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Review report on UFBS for European and Chinese resilient cities

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Summary

Deliverable 1.2 is intended to be a guide, a structured interpretation and evaluation of the current knowledge used to collate evidence on intended outcomes and unintended impacts of UF-NBS for urban ecosystem regeneration and human wellbeing. The information reported herein is based on the compilation of a reference-recorded knowledge repository of UF-NBS and their impacts on urban liveability, public health, halting biodiversity loss and re-diversifying UF-NBS structures to enhance urban resilience; specifically, Task 1.2 ? ?Reviewing the knowledge on the importance of UF-NBS for resilient cities? and M1.3 ? the ?Repository on UF-NBS for resilient cities in China and Europe?. Sections 2 and 3 of deliverable D1.2a are intended to provide a review of current UF-NBS practices in Europe and China. The in-depth coverage of these UF-NBS case studies is further expanded in Appendix 1 by reviewing the grey literature, i.e. the project and official reports, planning strategies, as well as scientific publications that span the territory of EU Member States and China. This documentation highlights the main goals and methodologies used in UF-NBS research and implementation, policy implications and NBS typology and functions, i.e., ecosystem services, within the frame of Task 1.2, as well as case history templates (Task 1.4). In Section 4, a comparative analysis of case histories provides conclusive insights into common or contrasting aspects in and between these two continents. Final considerations drawn from the comparative analysis of the intended outcomes of UF-NBS implementation include lessons that can be learned and existing knowledge gaps. In Section 5, a Sino-European analysis, in the form of a modelling exercise, was conducted of the selected case histories to explore shared themes, such as connectivity, multifunctionality and social cohesion, and macro-categories (i.e., ecological, engineering, social and economic macro-categories) for urban regeneration and renaturing. The second part, D1.2b, presents a review of the existing knowledge on UF-NBS through a compiled knowledge repository of cases from the academic literature as provided by both Europe and China. This repository offers a more comprehensive understanding of the overarching goal the overall document aims for, as well as its specific objectives, and to help satisfy the need for inquiring on the multitude of aspects that are inherent to UF-NBS and their strategic role in planning, ...

Approval

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Reviewing the knowledge on the importance of UF-NBS for resilient cities (D1.2)

Deliverable 1.2 is in two parts which reflect the two high-level themes dealt with in this task. Part D1.2a is a “review of current UF-NBS practices in Europe and China”. It draws on grey literature gathered by CLEARING HOUSE researchers and newly gathered primary literature called “Case Histories” of UF-NBS projects. Part D1.2b is a review of academic literature on UF-NBS projects developed in both Europe and China using an analytical tool to create the required evidence base and search for successful cases.

D1.2a – Review of current UF-NBS practices in Europe and China

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EXECUTIVE SUMMARY

Deliverable 1.2 is intended to be a guide, a structured interpretation and evaluation of the current knowledge used to collate evidence on intended outcomes and unintended impacts of UF-NBS for urban ecosystem regeneration and human wellbeing. The information reported herein is based on the compilation of a reference-recorded knowledge repository of UF-NBS and their impacts on urban liveability, public health, halting biodiversity loss and re-diversifying UF-NBS structures to enhance urban resilience; specifically, Task 1.2 – *‘Reviewing the knowledge on the importance of UF-NBS for resilient cities’* and M1.3 – the *‘Repository on UF-NBS for resilient cities in China and Europe’*.

Sections 2 and 3 of deliverable D1.2a are intended to provide a review of current UF-NBS practices in Europe and China. The in-depth coverage of these UF-NBS case studies is further expanded in Appendix 1 by reviewing the grey literature, i.e. the project and official reports, planning strategies, as well as scientific publications that span the territory of EU Member States and China. This documentation highlights the main goals and methodologies used in UF-NBS research and implementation, policy implications and NBS typology and functions, i.e., ecosystem services, within the frame of Task 1.2, as well as case history templates (Task 1.4). In Section 4, a comparative analysis of case histories provides conclusive insights into common or contrasting aspects in and between these two continents. Final considerations drawn from the comparative analysis of the intended outcomes of UF-NBS implementation include lessons that can be learned and existing knowledge gaps. In Section 5, a Sino-European analysis, in the form of a modelling exercise, was conducted of the selected case histories to explore shared themes, such as connectivity, multifunctionality and social cohesion, and macro-categories (i.e., ecological, engineering, social and economic macro-categories) for urban regeneration and renaturing.

The second part, D1.2b, presents a review of the existing knowledge on UF-NBS through a compiled knowledge repository of cases from the academic literature as provided by both Europe and China. This repository offers a more comprehensive understanding of the overarching goal the overall document aims for, as well as its specific objectives, and to help satisfy the need for inquiring on the multitude of aspects that are inherent to UF-NBS and their strategic role in planning, implementation and as a response to address today’s climate change, economic and social crises. In light of the aforementioned objectives, D1.2 can be considered a valid and comprehensive aide to a variety of audiences. These include, but are not limited to, educational and scientific research institutions, NGOs, environmental planners and enthusiasts, and lastly, government authorities who are expected to devote more importance, time, and budgets to green space management and allow for greater place-based involvement.

KEYWORDS

Ecological connectivity, Ecosystem services, Nature-based solutions, Public health, Sustainable urbanisation, Urban forests, Urban resilience

ABBREVIATIONS

UF-NBS: urban forests as nature-based solutions

KEY DEFINITIONS

Nature-based solutions (NBS): solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. (European Commission, 2016; Faivre et al., 2017)

Urban forestry: the integrated and multidisciplinary approach to planning and managing all forest and tree resources – ranging from street trees to peri-urban woodlands – in and near urban areas. (Konijnendijk et al. [Eds.], 2005)

Urban forests: tree-based urban ecosystems that address societal challenges, simultaneously providing ecosystem services for human well-being and biodiversity benefits. Urban forests include peri-urban and urban forests, forested parks, small woods in urban areas, and trees in public and private spaces. (Escobedo et al., 2011; FAO, 2021)

Urban tree(s): usually long-living woody organism(s) including woody shrubs, frequently single stemmed, with the potential to grow at a site in an urban or peri-urban area. Examples include roadside trees, trees in square or in parking areas, in parks and private gardens. Urban trees appear as individual or as groups of trees.

Urban forests as nature-based solutions (UF-NBS): a subset of nature-based solutions, that build on tree-based urban ecosystems to address societal challenges, simultaneously providing ecosystem services for human well-being and biodiversity benefits. UF-NBS include peri-urban and urban forests, forested parks, small woods in urban areas, and trees in public and private spaces.

Climate change: significant changes in global temperature, precipitation, wind patterns and other measures of climate that occur over several decades or longer.

Public health: the art and science of preventing disease, prolonging life and promoting health through the organised efforts of society. (WHO, 2021)

Sustainability: Living and managing activities in a way that balances social, economic, environmental and institutional considerations to meet [...] needs and those of future generations. (Fraser Basin Council, 2009)

REFERENCE

DeBellis, Y., Laforteza, R., Davies, C., Jin, J., Haase, D., Kronenberg, J., Roitsch, D., et al. (2020). *Reviewing the knowledge on the importance of UF-NBS for resilient cities (D1.2)*. H2020 project CLEARING HOUSE, agreement no. 821242.

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1 Compiling a reference-recorded knowledge repository

1.1 Introduction and main objective

It is believed that UF-NBS can help maintain, enhance, restore and reconnect urban ecosystems for strengthening public health and wellbeing (EC, 2015). A review of the literature on green space projects at urban scale is an essential tool to help create the evidence base for successful UF-NBS implementation.

The main objective of D1.2 in CLEARING HOUSE is to review existing resources from the international and national literature in Europe and China on UF-NBS to investigate their impacts on urban liveability, public health, biodiversity loss and urban resilience. For this purpose, we set out to build a reference-recorded knowledge repository from examples of case studies in Europe and China. This entails two main objectives: 1) a literature review of UF-NBS practices in Europe and China, including a review of the academic literature on UF-NBS projects developed in both continents, and 2) a comparative analysis of the resulting cases for their in-depth understanding. To allow us to complete these tasks researchers determined that it would be necessary to understand how the concepts, strategies and research projects on UF-NBS, ecosystem services, and urban forestry link to real-world cases in Europe and China and what main synergies and gaps/differences exist between them.

This review (D1.2, month 17) is intended to highlight existing opportunities for action and policy-making of UF-NBS as well as the knowledge gaps and barriers to their uptake, and thus lead to understand UF-NBS applications, impacts and key lessons for a second-stage investigation of resources of other CLEARING HOUSE work packages. In essence, this document is intended to help create the evidence base for successful UF-NBS implementation (European Forest Institute, 2018). It will feed into the Sino-European co-design event (T3.1) and the analytical framework (T1.5).

1.2 Methodology for compiling the reference-recorded knowledge repository

The general approach used to compile the reference-recorded knowledge repository was to conduct a search of several different sources: material provided by the case study partners, online websites and platforms, and personal interviews. Certain case study data from partners include a collection of ‘grey’ literature in terms of practitioners’ working material (i.e., official documentation – reports, projects, plans and programmes, maps, conference proceedings, and publications) (see Appendix 1). Case history templates from T1.4. (see *Step 2* below) were also used and served as an analytical tool. Tacit (stakeholder) knowledge and personal experiences complement the review through semi-structured interviews with practitioners and experts.

All project partners contributed to the database by providing relevant documentation within their geographical or topical scope. Aside from tapping into online NBS platforms, such as OPPLA, ThinkNature, CONNECTING Nature, GREEN SURGE, and GrowGreen, the approach used to collect the UF-NBS data consists of the contribution that each CLEARING HOUSE project partner has provided from their respective country on one or more past or ongoing UF-NBS case studies. Each partner selected those which are considered to be of particular relevance or that carry strong potential as emblematic cases of UF-NBS. The core group of project partners are the following:

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- The University of Bari Aldo Moro, Italy (UNIBA)
- The University of Hong Kong (HKU)
- Humboldt-Universität zu Berlin (HUB)
- Research Institute of Forestry - Chinese Academy of Forestry (CAF-RIF)
- Vrije Universiteit Brussel (VUB)
- European Forest Institute (EFI)
- Uniwersytet Łódzki (UniŁódzki)
- LGI Consulting Sarl (LGI)
- Hrvatski Sumarski Institut (CFRI)
- Centro de Investigación Ecológica y Aplicaciones Forestales Consorcio (CREAF)
- Natural Resources Institute Finland (LUKE)

The process for building the knowledge repository was carried out in three steps; these are:

Step 1: Collection of past and ongoing projects and case studies in Europe and China on UF-NBS (M1.3).

Project partners from Europe and China were requested to provide UF-NBS case studies, whether already implemented or in progress, online and printed (e.g., Naturvation) and grey literature (e.g., official reports, plans, scientific publications). This material has been uploaded as case studies in OPPLA – Milestone 1.3: ‘*Repository on UF-NBS for resilient cities in China and Europe*’ (Table 1). A second dataset (see: <http://doi.org/10.5281/zenodo.4590155>) includes resources, provided by project partners and through internet search, from the national and international scientific literature in Europe and China on topics of interest in relation to NBS, such as ecosystem services, urban forestry, green space rehabilitation, sustainability, citizen participation, public health, and climate change, to name a few. The focus is on UF-NBS that help restore, reconnect and rehabilitate urban ecosystems and habitats for the strengthening of public health and wellbeing as well as their impacts on urban liveability, halting biodiversity loss and re-diversifying UF-NBS structures to enhance urban resilience.

The rationale for the selection of case studies was based on the following:

- Geographical regions in Europe and China (i.e., city, city-region, region, country)
- Focus on the restoration of urban and peri-urban tree-based ecosystems – from creating forests to restoring the forest properties (in response to societal demands); the core issue should be a challenge to be solved through forest restoration and/or changing forest management
- Socio-economic settings (e.g., forest restoration in industrial areas versus amenity forests in boom towns)
- Ecological settings (e.g., climate or soil diversity)
- Varied management approaches (e.g., timber-oriented management, recreation management, no active management)
- Ecosystem services (carbon sequestration, biodiversity conservation, water regulation, soil and nutrient regulation, landscape and recreation and/or cultural ecosystem services, production of wood and non-wood forest products)
- Various stages of implementation of policies or mechanisms

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Step 2: Collection of case history templates (Task 1.4). Each partner country selected and provided a project, or case history, to showcase as a model of UF-NBS in the form of a template to be included in the reference-recorded knowledge repository (see: OPPLA.eu). The template records various types of information regarding the case history, such as geographic scale, key facts and figures, a location map, local stakeholders, UF-NBS actions and non-UF-NBS actions, UF-NBS typology, governance arrangements, and institutional and economic frameworks. Potential users of the templates are practitioners and experts of urban forest management, government authorities and stakeholders at different spatial scales, scientific researchers/institutions, health institutions and public/private organisations.

Step 3: Compilation of a reference-recorded knowledge repository (D1.2b). Project participants and contributing partners of this deliverable undertook an academic literature review, forming part D1.2b of this guide, to compile a reference-recorded knowledge repository. The review includes academic literature on UF-NBS projects, and specifically ecosystem services and urban forestry, developed in both Europe and China. The partners developed an analytical approach which allowed the assessment of findings and a Sino-European comparison of the literature. Therefore, an evidence base was built to highlight successful UF-NBS implementations and their impacts on urban liveability, public health, halting biodiversity loss and re-diversifying nature. The academic literature for Europe and China in D1.2b can be accessed at the following link: <http://doi.org/10.5281/zenodo.4590155>. The content for China is in English and Mandarin and partly behind paywall. The outcomes of the review are accessible through a dashboard at <http://review.clearinghouseproject.eu>.

The methodology used for building the reference-recorded knowledge repository consisted in using rapid review methods (Patnode et al., 2018). For D1.2a specifically, (i) a structured interpretation and comparative analysis of current UF-NBS practices in Europe and China was conducted, based on evidence of intended outcomes and unintended impacts of UF-NBS for urban ecosystem regeneration, resilience and human wellbeing (see also M1.3) (section 4), as well as (ii) a modelling exercise demonstrating the existence of a common shared approach for UF-NBS implementations between Europe and China (section 5). The methodology applied for D1.2b, a compiled knowledge repository on UF-NBS based on the review of academic literature, was based on searching SCOPUS - the largest multidisciplinary scientific database of peer-reviewed literature. To search for the academic literature on UF-NBS, a search code and key terms reflecting the objectives of the review were used to assess the effects or impacts of trees/urban forest as NBS on biodiversity, human health and well-being, and liveability in cities. More specifically, the following steps were taken: (i) querying of relevant literature in the SCOPUS database; (ii) screening of records that were returned from the query; (iii) processing and analysing the records from an internal data store collecting the output of a web-based paper survey; and (iv) presenting the findings. The process was designed to allow for a continuous updating of findings in an iterative manner.

Table 1. Step 1 - Building the UF-NBS knowledge repository for Europe and China (M1.3).

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Country	Document type(s)
Barcelona, Spain	<ol style="list-style-type: none"> 1. Document describing green infrastructure policy, plans, projects of the province and metropolitan area of Barcelona (weblinks); EU Projects related to ecosystem services (trees, forests), UF-NBS and healthy cities (weblinks); Reports at local – city level, metropolitan area, Province of Barcelona; scientific publications 2. Maps of the Metropolitan Area of Barcelona and Province of Barcelona on biomass, biodiversity, and ecological connectivity
Brussels, Belgium	<ol style="list-style-type: none"> 1. Regional projects: https://vub-my.sharepoint.com/:f:/g/personal/nicola_da_schio_vub_be/Eh6fe2VSw_ZDivmeDfDNk0sBcUCCTJlWrqousMitC46kZw?e=39hLVu 2. NBS case studies also engaging citizens (e.g., "Inspirons Le Quartier ") 3. Projects in Brussels (e.g., CO-NATURE) and Flanders 4. Project reports and scientific publications
Zagreb, Croatia	<ol style="list-style-type: none"> 1. List of publications and projects with related weblinks (e.g., REGREEN, proGReg project on NBS); other projects focus on participatory management in urban forest governance 2. Urban green plans, strategic reports 3. Scientific publications focus on, e.g., green infrastructure to minimise climate change; survey on urban nature park users' preferences
Ljubljana, Slovenia	<ol style="list-style-type: none"> 1. Urban green projects in Ljubljana; European Union NBS projects (e.g., GREEN4GREY) 2. Municipal plans/"European Green Capital 2016" 3. Scientific publications on urban forest research in the Mediterranean; soil assessment in urban parks; challenges to governing urban green infrastructure in Europe
Helsinki, Finland	<ol style="list-style-type: none"> 1. UF-NBS cases focusing on forests and wellbeing (e.g., Kintterö Health Forest) 2. Projects/reports (describing key aims, key message, method, with weblinks) 3. Scientific publications (plus table): focus on human health and nature
Leipzig, Germany	<ol style="list-style-type: none"> 1. NBS research projects (e.g., CONNECTING Nature) 2. Federal and state plans, reports (e.g., TU Dresden Research Report) and policies 3. Scientific publications regarding NBS (e.g., Guidelines for action for urban forests in NRW; ecosystem services of urban forests)
Krakow, Poland	<ol style="list-style-type: none"> 1. Document - the '2022 European Green Capital Award': overview of the city of Krakow 2. Plans and programmes: Poviats program to increase the forest cover of the City of Krakow for 2018-2040 3. The "2022 European Green Capital Award": overview of the city of Krakow
Belgrade, Serbia	<ol style="list-style-type: none"> 1. Revitalization projects: https://www.beograd.rs/images/data/98e470b6829e9ce1a59ff91b9a926ad2_1251546056.pdf 2. Strategic plans and NBS projects (e.g., URBforDAN) 3. Scientific publications
Milan, Italy	<ol style="list-style-type: none"> 1. PNM case study- Milan (NBS project; template provided); governance instruments: https://parconord.milano.it/scopri-il-parco/spazi-e-attrezzature; UF-NBS case studies in Bari and Turin, Italy 2. Planning documents, conference proceedings, scientific publications and weblinks
Vienna, Austria	<ol style="list-style-type: none"> 1. Novel and legacy UF-NBS projects (e.g., Else Feldmann Park and the Danube Park) 2. Strategies and programmes (Vienna) 3. List of development plans for the city of Vienna (e.g., Step 2025)
France/Sweden	<ol style="list-style-type: none"> 1. Swedish–French EU Life-Environment Project "Urban Woods for People" 2. Reports; agency web portal featuring a collection of actions on climate and biodiversity using NBS; regional guides on forest management and climate change (Paris) 3. List of scientific publications
Paris, France	<ol style="list-style-type: none"> 1. Strategy and programs related to the implementation of NBS in urban areas in France 2. Actions, projects & planning at city level (e.g., Paris City Hall's greening program for 2014-2020); research projects (e.g. SESAME - EcoSystemic Services provided by Trees Modulated according to Species) 3. Reports and scientific papers
Beijing, China	<ol style="list-style-type: none"> 1. Plain Area Afforestation Programme (template provided) 2. Planning instruments: Beijing Urban Greenspace Planning (2004-2020), Beijing Master Planning (2018-2035) and National Standard of Forest City Construction (GB-T 37342-2019) 3. Scientific publications

2 UF-NBS case studies in Europe

This section presents urban ‘tree-based’ UF-NBS case studies and projects in Europe. For the European cities selected for the review, one or more UF-NBS case studies have been reported. The scope of this section is not to make a comprehensive list of all the existing case studies in Europe, but to provide an overview of selected examples of UF-NBS implementations. It is worth noticing that these examples were supplied by the project partners for their respective countries. We have analysed all the material received and summarised each example of UF-NBS to highlight the main typology, objectives and intended impacts. Indeed, the selected UF-NBS include various typologies, such as fluvial parks, urban woods, and urban orchards, which made it difficult to create a homogeneous and consistent structure for discussing all the cases. Nevertheless, effort was directed towards the organisation of these cases in a meaningful way so they could be used as testbeds for further implementation of UF-NBS. The following case studies are meant to complement the subsequent analysis of the case histories in Sections 4 and 5.

2.1 Spain

Barcelona

SITxell project. Since 2001, Barcelona Provincial Council has been drawing up a territorial information system, the project SITxell (acronym in Catalan for Territorial Information System for the Network of Open Areas in the province of Barcelona), which contains a categorisation and assessment of non-urban land based on the analysis of its ecological and socio-economic characteristics (<http://www.sitxell.eu/en/default.asp>). SITxell is a cartographic and alphanumeric database, which helps with the study, analysis, evaluation and planning of open areas in the province of Barcelona. The conceptual basis of this tool lies in the conviction that open spaces as a whole are the basic territorial system upon which settlement and infrastructure systems must properly be placed, so that open areas maintain their key ecological and socio-economic functions. It is therefore essential to understand the main features of these areas - both their intrinsic characteristics and the attributes associated with overall processes within the network of open spaces.

On the technical side, SITxell is a project concerning territorial analysis, which is structured through different layers of geographical information and intended to study and evaluate the open areas of the province. Among the layers of geographical information, a complex set of biodiversity, ecosystem functions (i.e., ecological connectivity) and ecosystem service indicators (both supply and demand) was created for the Province of Barcelona. Most of the cartographic information is presented at a detailed resolution (i.e., 20 m). Based on these data, recent studies have developed an operational framework for green infrastructure planning at the landscape scale (Basnou et al., 2020).

On a political level, SITxell is a tool intended to influence land planning processes, on both local and regional scales, by providing accurate and reliable socio-economic and ecological information and criteria for plans and projects developed by competent authorities. The success and influence of SITxell since its launch have been based on the strength and usefulness of the information, applicable in land use planning at different scales and in other specific types of planning (water, agriculture, conservation of habitats and species, strategic environmental

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assessment, etc.). Secondly, strong partnerships with various levels of government, universities, research centres and the private sector (specialised consultants, farmers associations, and NGOs) have been established that have ensured the quality of information and the maximum objectivity of analysis.

Madrid

The Autonomous Community of Madrid planned to develop an ecological corridor network at regional level as an opportunity for integrated social welfare and natural heritage conservation. One of the specific objectives is to create a metropolitan green ring (suburban green corridor) based on the existing urban and metropolitan parks. The initiative is now in the project phase. The benefits of the project have not yet been estimated in detail; however, this initiative focuses on ecosystem service provision and resilience. In comparison with the lead example, the cost/ha ratio appears to be more favourable (IEEP et al., 2010). There has been progress since 2010, for example, in 2016 Madrid announced that it will examine a non-legislative proposal from various ecologists and neighbourhood associations to create an ecological corridor South-East of Madrid that links the ‘Casa de Campo’ and the regional park ‘del curso medio del Guadarrama’ (Ayuntamiento de Madrid, 2016).

2.2 Belgium

Brussels

The Brussels Environment Agency call for projects **Inspirons Le Quartier (Let us inspire the Neighbourhood)** was launched in 2016. More specifically, the intent was to engage citizens in supporting the realization of collective neighbourhood projects. Both methodological as well as financial support (up to 15,000 EUR) has been provided. Each year this call invites the citizens of Brussels to propose a sustainable project that they would like to develop in their neighbourhood. The project must be citizen-led, built by and for the inhabitants of the neighbourhood by bringing together the ideas, resources, motivations and skills of each. The aim is to energize and improve the quality of life in the neighbourhood by mobilizing its inhabitants around the preservation of the environment and sustainable development. All the major environmental themes can thus be addressed in the proposed projects, such as sustainable citizen neighbourhoods, good food, collective compost, energy, green neighbourhoods, and zero waste.

The **CO-NATURE (Co-producing scenarios for nature-based urban regeneration)** 4-year research project is a team effort among local stakeholders, citizens, and policymakers and a collaboration between the Université Libre de Bruxelles and Vrije Universiteit Brussel. The project pursues three principle objectives:

- An inventory, classification and suitability mapping of nature-based solutions for urban regeneration
- An understanding of urban green space use and valuation from the perspective of cultural ecosystem services
- Co-producing alternative scenarios through participatory research-by-design workshops for developing Nature based Urban Design and policy guidelines

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The project focuses on two areas in the Brussels Capital Region. The first, **Plan Nature**, is implemented by the Bruxelles Environnement Agency and aims to improve access to nature by inhabitants, to facilitate collaboration between green space management stakeholders and to build multifunctional green space or spaces that offer a wide range of ecosystem services to support both biodiversity and the city as a whole. The second is **Plan Canal**, which focuses on the former industrialised Canal Zone of Brussels. The initiative aims to stimulate local economic activity and local job creation, to create housing to keep up with population growth, and to build public space to serve as a platform for engagement and unification.

The Canal Zone has historically been dominated by industry and commercial activity. The Canal was constructed in 1477 to connect Brussels to Antwerp, and served as a port for trade of tapestries and other fabrics. This construction significantly reduced the time taken to transport goods. Warehouses, shops, hotels, and factories were built along the Canal to support this lucrative port. Growth and expansion of the canal continued into the 20th century, until Brussels experienced a downturn in its population from the 1970s as the middle and upper classes escaped the city centre and moved to the outskirts. De-industrialisation transformed the canal area, where industry was gradually replaced by logistics companies. As a result of de-industrialisation, brownfields have emerged and buildings have deteriorated along the canal. There has since been a push to spur development of industrialised zones, which has resulted in some revitalisation and repopulation of portions of the canal. However, other areas still struggle, impacted as well by pressures from the population boom Brussels has experienced in recent years.

The overall goal of the CO-NATURE project is to explore the potential of incorporating cultural and regulating ecosystem services and NBS urban design into development plans for Brussels. The objectives of this project are threefold:

- First, to identify which NBS could potentially be implemented in Brussels and where these implementations would be most beneficial.
- Second, to understand how green spaces are used and valued or, in other words, to identify the beneficial cultural ecosystem services present and lacking in Brussels green spaces.
- Third, to develop scenarios with experts and citizens to ultimately inform policies that could be used to guide nature-based urban design.

Flanders

A green space study was carried out by **Natuurpunt**, a nature conservation NGO (member of Birdlife International). The study looked into the availability of green space at walking distance for the Flemish population. Three million Flemish people find no nature within walking distance of their homes. This is the conclusion of the study on the basis of the Spatial Model Flanders of the Flemish Institute for Technological Research (VITO). In addition, it appears that each inhabitant of the province of West Flanders has on average 5 times less nature at his/her disposal than an inhabitant of Limburg, and that inhabitants of central cities such as Ghent and Roeselare hardly find any nature. Natuurpunt requested the Flemish government to enshrine the guidelines for nearby nature, the so-called green standards, and in the meantime to work on new nearby nature and urban forests, so that every Flemish person would be able to go out into a nature area in his/her surroundings.

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Nature within walking distance is a matter of social importance. In order to be used effectively, nature must also be easily accessible and within a radius of 1.6 km. A recent VITO study showed that 10% more green space in the living environment corresponds to a savings of 214 Euros per inhabitant for social security. Flanders already noticed this potential in 1993 and translated it into the Flemish directives of nearby nature, the so-called green standards. Natuurpunt's report shows that there is still work to be done to make these green standards a reality. Only 46% of the Flemish population find an area of 30 ha in the vicinity of their homes. No less than 3 million Flemish people have to do without such an area. The differences between the provinces are large. Limburg scores relatively high. Sixty-six percent of the Limburg population finds peace and quiet in nature at 1.6 km from their home. Of the 20 municipalities that provide nature within walking distance for each inhabitant, half are located in Limburg. The province of Antwerp is also doing relatively well. Sixty-two percent of the inhabitants can walk in a nature reserve at their doorstep. The municipalities that provide nature for every inhabitant are mainly located in the green Campines region: Grobbendonk, Vorselaar and Vosselaar. Flemish Brabant represents the Flemish average. Half of the Brabant residents can go for a walk in the vicinity of their home. East Flanders dives well below the Flemish average: only 30% of the people from East Flanders currently find a piece of 30 ha of nature within walking distance. For the people of Ghent this is only 8 percent. West Flanders is the worst off: 76% of the inhabitants in this provinces do not find a large nature reserve within walking distance of their homes. In Roeselare no inhabitant finds 30 ha of nature within walking distance. The need for more nature is high: an online survey of more than 15,000 Flemish people showed that 8 of 10 Flemish people think there should be nature less than 2 km from their home. Moreover, the heat island effect and increasing population density will further increase the importance of accessible nature in the future, especially in the Flemish central cities. Natuurpunt asked Flanders to enshrine the long-term plan drawn up in 1993 with a decree by 2016. In the meantime, new nearby nature and urban forest projects needed to be implemented. The Government considered the amendment of the nature decree which forms the framework for the Flemish nature policy for the coming years. This mainly focuses on areas which have European protection (habitat and bird directives). These are indeed very important, but the areas that fall outside them could hardly be extended. This is bad news for those looking for nature within walking distance: in regions where there is already a lot of nature, nature will be added, but in regions where there is currently little nature, nature will not be added either. Natuurpunt asked Flanders not only to have an eye for nature of European importance, but also to spend resources on nature that is important locally.

2.3 Sweden

Stockholm

A joint Swedish–French EU Life- Environment Project **Urban Woods for People** demonstrates new ways of increasing the recreational benefits of urban woodlands. During the period 2001–2005, over 40 activities were carried out in the pilot woodlands; Skutan, Norra Djurgården, Huddinge (14 woodland areas) all situated in suburban Stockholm, Sweden and the Sénart forest located outside Paris, France. The project can be considered as a toolbox of customised tools for developing the qualities of urban woodlands, and the know-how contained in the handbooks can be applied to other kinds of urban nature areas. All the handbooks and manuals

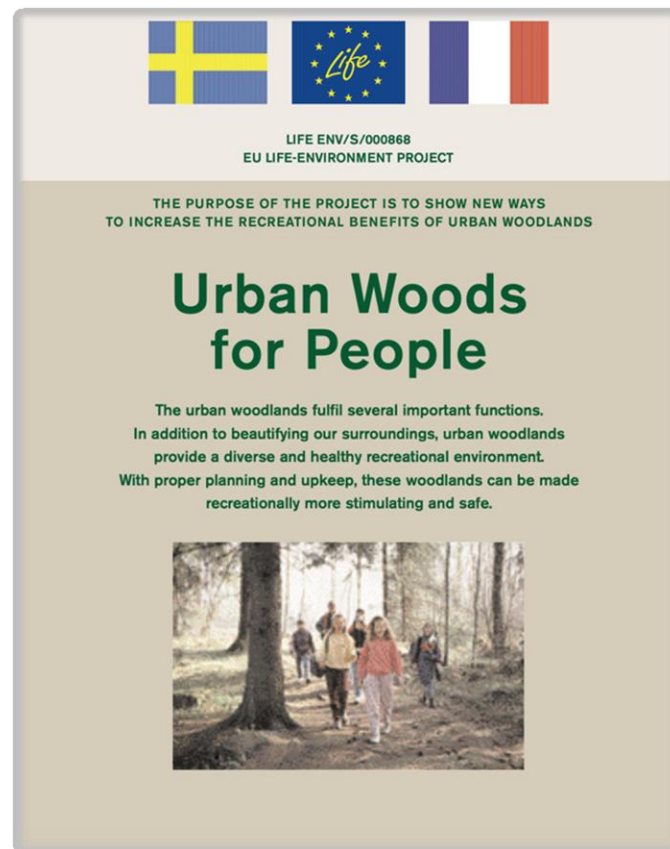
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can be described as innovative, since they all contribute to fulfilling a need of new knowledge that is sought after by administrators, forest managers, urban planners and others who work with urban nature zones. Another innovative aspect of the project is that the Swedish Federation for Disabled Persons has been an active partner throughout, working with increasing accessibility for the mobility impaired in the pilot woodlands. International conferences and training courses are also an innovative aspect of the project. This was also highlighted when the European Forum in Urban Forestry, originating from IUFRO, took place in Stockholm with Urban Woods for People acting as host. The results of the project can also be regarded as a contribution to the EU's work with the sixth action programme for the environment, Environment 2010 – Our Future – Our Choice.

The project overview describes the success factors for obtaining each individual goal related to increasing the recreational benefits of urban woodlands. The following are a few examples of goals and success factors aiming for this purpose: *goal 1*: “The use of guides to attract people who normally are unaccustomed to being out in the woods”; *success factors*: a suitable guide who is a good communicator; choosing attractive sites; subsidising guiding costs so they are free of charge for children; *goal 2*: “How to increase the recreational value of urban woodlands”; *success factors*: e.g., use of brochure dispensers to provide a low-cost alternative to reach visitors; advance accessibility description to assist the elderly and physically impaired with prior information; attractive entrances; *goal 3*: “Generate support to research how woodlands are used by the general public”; *success factors*: use small groups; let the participants find solutions. These indicators show that even with simple steps, it is possible to increase the recreational benefits of urban woodlands.

The outcomes of the project include an improvement of recreational opportunities in all the pilot woodlands on the part of the general public. Knowledge about the importance of urban woodlands for man's well-being also increased amongst the administrators, managers and others who have read the handbooks and manuals, the newsletters, taken part in the field trips, training courses and the conferences organised by the project. Improving the health of the general public is a big money saver for society. Hence, cost savings were also gained by the project. A good example of measurable cost reduction gains is the result of the litter management plan developed in Sénart. By removing 30 of 45 litter baskets, the volume of litter dropped by 80%. This, in turn, led to a savings of two work days per week for litter collection. It remains to be seen how large the cost reduction gains become as more people use the urban woodlands for recreational purposes with maintained or improved health as a result. The experiences gained from Urban Woods for People will be integrated into the daily operation of the main project partners, the National Board of Forestry, the Regional Forestry Board of Mälardalen in Sweden and the Office National des Forêts, ONF, in France.

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**Joint Swedish–French EU Life-Environment Project
‘Urban Woods for People’.**

2.4 France

Lyon

Strategies and programmes related to NBS

The **Canopy Plan** is an initiative of the Metropolis of Lyon whose objective is to create a link between the Tree Charter and the previously adopted Territorial Climate Energy Plan. This plan, designed to develop and protect the urban forest, must enable the discovery of qualitative, natural and sustainable solutions to adapt the city to climate change. The interest is to intensify the efforts undertaken for more than 25 years in favour of urban trees through awareness and the mobilisation of a growing number of actors and inhabitants of the Lyon Metropolis. The Metropolis is thus committed to increasing the rate of tree planting in metropolitan areas to reach an additional 3,000 trees per year and shaded road surfaces from 12% in 2016 to 20% in 2030. It also involves continuing efforts to diversify tree species in order to reach a threshold of 10% of the same species, 15% of the same genus and 20% of the same family. The most relevant sites will be determined to improve thermal comfort and limit urban heat island effects. (Link: <https://blogs.grandlyon.com/developpementdurable/en-actions/dispositifs-partenariaux/plan-canopee-larbre-au-service-du-climat-urbain>)

Strasbourg

Related to this plan is the **Vegetalisation/demineralisation strategy** of the city of Strasbourg. The objectives of this **Canopée plan** are broad: to improve air and soil quality, work for the well-being of the inhabitants and promote biodiversity. To achieve this, as many players as possible must contribute to the process. In addition to developers and businesses, the city seeks to involve citizen-users so that these projects can reach their full potential. Through an online form, citizens can suggest any space that would be suitable for planting a tree.

(Link: <https://demarches.strasbourg.eu/proprete/suggestion-plantation-arbre>)

The National competition French Capitals of Biodiversity - Each year, the national competition "French Capitals of Biodiversity" highlights exemplary actions to preserve biodiversity by municipalities and inter-municipalities. The theme of the 2019 edition was "Climate: nature as a source of solutions"; it rewarded communities acting jointly against climate change and biodiversity erosion through NBS. The theme for 2020 – 2021 is Water and Biodiversity. In addition to a competition to designate the French Capital of Biodiversity and the best local authorities by category (villages, small towns, medium-sized towns, large cities, inter-municipalities), the operation is above all a mechanism to raise awareness and identify and promote good practices. (Links: <http://www.capitale-biodiversite.fr>; https://www.ecologie.gouv.fr/sites/default/files/ONERC_Rapport_2019_SfN_WEB.pdf)

The EcoQuartier initiative – As part of the “ÉcoQuartier” initiative developed by the Ministry of the Environment, Energy and Sea, Territorial Cohesion and Relations with Local Authorities, a methodology to guide the project leader in the design of a neighbourhood has been developed. The methodology is based on a set of 20 commitments grouped into four categories: approach and process; living environment and uses; territorial development; and environment and climate. The objective is to encourage the implementation of initiatives that meet the needs and specificities of the territories and to adopt a progressive approach towards a sustainable city.

(Link:

https://www.ecologie.gouv.fr/sites/default/files/ONERC_Rapport_2019_SfN_WEB.pdf)

Perpignan

Sant Vicens Park, in the city of Perpignan, will eventually cover an area of 11 ha and be the result of two joint approaches, hydraulic and landscaping, under the responsibility of Perpignan Mediterranean Metropolis and the City of Perpignan. The park, formerly cultivated with irrigated orchards, has been strongly planted by local residents, associations, schools and by the green spaces department. The main objective of the plan is to counter a flood-prone area by creating water retention basins (including the parking lot and stadium). The gradient of water presence (permanent, temporary, absent) allows the development of varied ecosystems. All the technical solutions are part of a sustainable development approach: the creation of fertile soil with compost and plant mulch from green waste; no use of chemical fertilizers; supplying the park's water network with rainwater and irrigation water; and local species planted that can withstand drought. (Link : <https://uicn.fr/wp-content/uploads/2020/01/sfn-light-ok.pdf>)

Orléans

Through the various plans that the city of Orléans, known as the **Garden City**, has adopted (the Biodiversity Plan - one of the first in France as early as 2009; the Climate and Energy Territorial Plan in 2012), many operational solutions aim to maximise the presence of plants in the city. Numerous public parks and private gardens, more than 25,000 trees, as well as natural and agricultural sites are interwoven throughout the territory and constitute the elements of an urban green grid. In addition to the knowledge and monitoring of local biodiversity (with regular inventories since 2010), ecological management of green spaces has eliminated the use of phytosanitary products for the management of public spaces over the past 5 years. The City of Orléans wishes to promote plants in the landscape to improve the living environment and reduce urban heat islands thanks to the evaporation process of plants that humidify and cool the air. During urban development operations, residents are allowed to participate in the greening operations of public spaces. (Link : <https://uicn.fr/wp-content/uploads/2018/06/brochure-sfn-mai2018-web-ok.pdf>)

Paris

Actions, projects and planning at city level

Plan Biodiversité 2018-2024: Biodiversity Plan - The new Biodiversity Plan is the result of consultation with Parisians submitted to the Paris Board of Directors on March 20, 21 and 22, 2018. The plan is divided into 30 consolidated actions along three axes: biodiversity in a committed city; biodiversity by and for all; and biodiversity everywhere. (Link: <https://www.paris.fr/pages/biodiversite-66>)

Nature in the city: “Végétalisons Paris”

Developing nature in the city is the ambitious objective of Paris City Hall's greening programme for the 2014-2020 term. The objectives of the mandate include, among others: 30 additional ha of green spaces open to the public; the creation of orchards and vegetable gardens in schools; the development of educational farms and apiaries; and "A tree in my garden" operation, whereby the City of Paris offers trees to citizens who want to plant in their private spaces. Other examples include: rooftop farming, consisting in the largest urban farm in Europe (15 000 m²) providing the sale of market garden products, educational workshops, and the organisation of events; the transformation of school playgrounds into "oases" (an initiative stemming from the Paris Resilience Strategy, adopted by the Paris Council in September 2017, which aims to strengthen the region's ability to meet the major climate and social challenges of the 21st century – the project was as part of the "Urban Innovative Actions" call for projects, a European Union initiative financed by the European Regional Development Fund, ERDF); also, four urban forests to be planted by the end of 2020 in different zones of Paris, totalling an extra 12.5 ha of green spaces with the planting of about 170,000 trees.

Research projects and tools related to UF-NBS

Nature4Cities. Through this European research project, whose scientific coordination is ensured by Cerema, an online platform offers a series of tools to implement nature-based city planning solutions. Numerous experiments carried out in Europe have been evaluated so that stakeholders can determine the most appropriate solutions for the context.

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Life Artisan. This integrated Life project coordinated by the French Office for Biodiversity (ex-AFB) aims to "Increase the Resilience of Territories to climate change by Encouraging Nature-based Adaptation Solutions". It obtains these goals by the capacity building of actors and by contributing to improve the institutional, financial and normative frameworks to generalise nature-based solutions.

Life Adsorb. A partnership research project conducted in Paris, which aims to evaluate a natural solution based on reed filters to reduce the pollutants present in rainwater. A prototype of a filtering basin has been set up by Cerema to evaluate the efficiency of the filter.

SESAME. EcoSystemic Services provided by Trees, Modulated according to Species is a project carried out in partnership with Metz and Metz Métropole to develop a decision support tool to select tree and shrub species to be planted in the city according to the ecosystem services provided by the different species. Through partnerships in other regions the SESAME project will be adapted to other climatic zones.

ScoreICU & Arbre en Ville (Trees in the City). Score ICU is a pedagogical tool on urban heat islands. It allows to qualify an urban space (square, street, plot, garden, island) and to propose a first analysis of the urban heat island phenomenon. **Trees in the City** is an approach to value the ecosystem services offered by trees in urban areas. The tool allows to quantify the benefits of urban trees in terms of carbon sequestration and atmospheric pollutants and to compare different tree species according to several criteria (urban heat islands, carbon, allergies, biodiversity, air quality, vulnerability) while taking into account the soils and climatic conditions encountered.

PROOF. Cerema is coordinating this research project, which focuses on the environmental and energy assessment of green roofs equipped with photovoltaic panels. The objective is to promote the deployment of these devices in cities.

ECOPS. A research project that aims to evaluate the phenomenon of evapotranspiration on small vegetated areas, such as those found in cities, and thus to better understand their impact on rainwater runoff or the reduction of the heat island phenomenon, for example.

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'NBS and Climate Change Report' – France, 2018.

2.5 Germany

Leipzig

The city of Leipzig initiated the project **Baumstarke Stadt (Tree-Strong City)** in 1996–1997. This UF-NBS initiative was implemented by the city authorities to attract people's attention to modern ecological issues and increase the popularity of ecological movements among the population by reforesting streets in the city. The aim of this project was to increase the tree stock in the city by planting new trees in public areas such as parks, streets, and urban cemeteries. The initiative consisted of tree sponsorship bids starting from 250 Euros paid by citizens or companies who were sponsors for the particular tree. Thus, the Tree-Strong City initiative in Leipzig is a creative and beneficial way to reforest the streets, which ultimately improves the quality of life since trees provide fresh air and contribute significantly to a liveable, green city. The project contributed to a greener city landscape and strengthened the attachment of citizens to their urban environment.

(Link: http://www.leipziggruen.de/de/2012_Baumstarke_Stadt.asp)

In Leipzig, a number of UF-NBS projects are spearheaded by the non-profit organisation ANNALINDE gGmbH. The company operates multifunctional urban agriculture projects and

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focuses on supporting the community and its sustainable development. One example of such projects is **Gemeinschaftsgarten**, established in 2011, which offers recreational opportunities over 2000 m² of large wasteland and includes more than 50 raised-beds and multiple greenhouses, where vegetables and herbs are cultivated. Citizens learn how to produce local food and create a new urban life setting. The main objectives of the project include enabling low-threshold education and participation opportunities. Activities are open to everyone and range from sowing, planting, harvesting over the extraction of seeds, processing and preserving of vegetables, keeping bees and chickens, the building of a vermicompost up to the development of new cultivation methods. Knowledge is thus acquired on biological diversity, urban ecology, climate adaption, recycling, sustainable consumption and future-oriented forms of urban life. (Link: <https://annalinde-leipzig.de/de/events/vom-industriebahnhof-zum-obstgarten/>)

The **Orchard** project, a second example, is a community gardening initiative in Leipzig to support orchards in the city. At the Citizens Train Station in Plagwitz, the ANNALINDE company developed 3400 m² of urban orchard meadow with emphasis on regional and heirloom fruit varieties. In 2016, ground vegetation was planted to foster ideal soil conditions, and in 2017 the Orchard was completed. In 2013, the NGO began to revitalise the nearly 150-year-old **Market Garden** using crop rotation for growing more than 100 varieties of vegetables. Also, food-bearing vegetables in two covered tunnels and seedlings are cultivated in a separate glass greenhouse. Two herb plots, an area for experimentation with specialty plants, shrub and blossom garden strips, and “edible hedges” complete biological diversity. Since 2014, the Garden is also home to 14+ bee colonies. Over 35 subscribers are supplied with the veggie box service (e.g., local chefs, specific events). The Garden is a training site for agriculture and assignment location for federal volunteers who are mainly responsible for the educational activities offered, such as tours and workshops with school classes and internships for university students.

Bürgerbahnhof Plagwitz (Citizens Train Station Plagwitz). Since 2013, the approximately 13-ha area of the former industrial train station Leipzig-Plagwitz is being transformed into the urban greening project “Gleis-Grün-Zug” (Platform-Green-Train). Between two streets, Karl-Heine-Straße and Schwarzstraße, green areas are being connected by bicycle and pedestrian paths. Link: www.buergerbahnhof-plagwitz.de. For all other projects and information, see <https://annalinde-leipzig.de/en/projects/>.

A trial and development **Urban Forests** project (2009-2019) was undertaken by the city of Leipzig and funded by the German Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN). The project was tested on three urban fallow areas. In parallel, the accompanying scientific research coordinated by TU Dresden examined the effects of forests on the natural balance and biodiversity in cities, on urban design and recreational suitability, urban redevelopment and the acceptance of the urban population using the test areas as well as a large number of older urban forests. The aim was to develop a toolbox for the creation of urban forests. The tests and investigations have shown that urban forests represent an integrative and innovative approach in urban development. As a result of the 10-year research project, information is available on: the three model areas in Leipzig; summary reports of the modules of the accompanying scientific research; and a three-part toolbox that helps with the planning, implementation and maintenance of urban forests. (Links: <http://urbane-waelder.de/>;

<https://www.leipzig.de/news/news/zweiter-urbaner-wald-schnauer-holz-in-grnau-freigegeben/>)

Projects

CONNECTING Nature (Nature – COproduction with NaturE for City Transitioning, Innovation and Governance). An EU-funded Horizon 2020 project dealing with developing innovative NBS for climate change adaptation, health and well-being, social cohesion and sustainable economic development in European cities. One of the core principals and strategies recommended for the creation and implementation of NBS is connecting existing networks and “learning by comparing” (Dushkova and Haase, 2020). The methodology for creating the NBS data and knowledge base developed within the CONNECTING Nature project is based on information focusing on how to allow different users to systematically assess and analyse the efficiency, effectiveness and sustainability of urban NBS interventions in Europe. This NBS data and knowledge base can be seen as an element of a European-wide, comprehensive and robust mechanism to monitor and evaluate the effectiveness of NBS implementation in cities with regards to database-specific impact categories (e.g., flooding, heat, health) and in terms of fulfilling the criteria of long-term deployment and sustainability. (Project link: <https://cordis.europa.eu/project/id/730222>)

2.6 Austria

Vienna

New UF-NBS projects

The new Else Feldmann Park - Green space instead of streets. This model project aims to provide more public space and climate protection policy for Vienna’s newest 2nd district (Leopoldstadt). Building a park instead of a street was a long-awaited expectation of neighbouring residents. The public participation process started in 2018 and demolition work began in April 2020. The old trees were preserved and 21 new trees were planted. Play and climbing equipment, a sandpit, horizontal bars, a drinking fountain, numerous seating areas and a wild fruit hedge found space on the 3,400 m² area. Link: <https://www.wien.gv.at/bezirke/leopoldstadt/umwelt/trunnerpark.html>

Climate protection facade of ma 48. The aim of this project was to green the facade of the public office building belonging to the Vienna City Administration (“MA48”). Such a facade creates ecological niches and living spaces for numerous insects and birds and has a positive effect indoors and the immediate outdoor climate. Using this measure, a technical solution (e.g., air conditioning) for regulating room climate becomes unnecessary, thus reducing energy consumption and reducing greenhouse gases. The construction of the 850 m² facade area was scientifically supported by the University of Natural Resources and Life Sciences. However, research into the effects of the climate protection facade will continue after the construction period has ended. In particular, it will focus on temperature and humidity measurements as well as the creation of radiation balances and vegetation recordings. Initial measurements have shown that the building's winter heat loss is reduced by up to 50%. The summer evaporation capacity of the “green fur” corresponds to a cooling capacity of around 45 air conditioning units (each with 3000 watts cooling capacity and 8 hours of operation) or four 100-year-old beech trees, which would take up the entire space of the building. Link:

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https://www.ecologic.eu/sites/files/publication/2014/eco_bfn_naturbasierte_loesungen_sept2014_de.pdf

Biotope City Wienerberg. Renaturalising the city: Leaf green is by far the most efficient and cost-effective means of mitigating heat stress and environmental after-effects. The Biotope City proves that both high-density and green housing are possible and affordable. The Biotope City Wienerberg is a development area in Vienna which shows that dense development and effective greening are compatible. From the very beginning, all the stakeholders involved have worked together on the basis of the mission statement “Biotope City”. To operationalize this mission statement, the planners, developers, consultants and municipal departments have subsequently drawn up a detailed quality catalogue.

At Biotope City, tall trees with a trunk circumference of up to 35 cm are planted from the very beginning. Inner courtyards and rooftop areas are used for gardening, the facades are planted with wild wine and wisteria (climbing plants), and the loggias and balconies are equipped with structurally already integrated planters. The design of partial areas as “G’stätt’n” (a Viennese German term for fallow land and natural grassland) and “rain gardens” is still largely untested in housing construction: Unsealed green surfaces serve as catchment and seepage surfaces during heavy rainfalls. (Link: <https://www.iba-wien.at/en/projekte/projekt-detail/project/biotope-city-wienerberg?fbclid=IwAR1Jk57TC69kz6azVJK42jdqu-2AsyWnFNbSi66Lo-OxVFpBZkdfBWkNReo>)

GrünPlusSchule@Ballungszentrum. This project focuses on the highly efficient facade and roof greening with photovoltaic combination, which is seen as optimal solution for energy efficiency from an overall ecological perspective. As part of this project, different building greening systems and plant/substrate types, combined with different photovoltaic modules, were examined at a Viennese school with the involvement of pupils. The project is funded as part of the BMVIT's “City of the Future” programme. (Link: <https://nachhaltigwirtschaften.at/de/sdz/projekte/gruenplusschule-ballungszentrum-hocheffiziente-fassaden-und-dachbegruenung-mit-photovoltaik-kombination-optimale-loesung-fuer-die-energieeffizienz-in-gesamtoekologischer-betrachtung.php>)

Schwammstadt ("Sponge City"). The Schwammstadt ("Sponge City") principle ensures that trees are supplied with sufficient water even in very hot weather and long periods of drought. This is made possible by an ingenious system in which sufficient ballast is created underneath the paved surfaces in the road space to store rainwater. This principle of planting the trees will be applied in the new development housing area in Vienna – Seestadt. (Links: <https://www.iba-wien.at/en/projekte/projekt-detail/project/schwammstadt-sponge-city>; <https://www.wien.gv.at/umwelt/coolswien/schwammstadt.html>)

Vienna’s open space network. As part of the Urban Development Plan Vienna (STEP 2025) the Vienna’s open space network is planned. Up to now, parks and the green belt surrounding the city have served as the structural core elements for green and open spaces in Vienna. The challenges urban planning has had to face in the last decades have brought about a higher degree of differentiation and functional definition. Vienna’s green and open space system is changing from a zone system to a network system. The development of this network promotes green

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space equity for the citizens as well as the preservation of the city's ecological, social and economic functions. (Link:

<https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008379b.pdf>)

Legacy projects developed using NBS principles

Donaupark Vienna. The Danube Park was redesigned from a former garbage dump to a park in 1964 as part of the "Vienna International Garden Show 1964" (WIG 1964) under the overall planning of the then City Garden Director Prof. Ing. Alfred Auer (1922 to 2002). (Link: <https://www.wien.gv.at/umwelt/parks/anlagen/donaupark.html>)

Donauinsel. The Donauinsel ('Danube Island') is a long, narrow island in central Vienna, Austria, lying between the Danube river and the parallel excavated channel Neue Donau ("New Danube"). The island is 21.1 km (13.1 mi) in length, but is only 70–210 m (230–689 ft) wide. The New Danube waterway is practically an elongated (swimming) lake, technically a diluvian be. The main purpose of the island however is to be part of Vienna's highly sophisticated flood protection system. As the river Danube crosses the city (before major extensions: passed nearby), this has been a constant concern over hundreds of years. The first notable protective measures were taken between 1870 and 1875. A central bed, 280 m, was dug out, and an inundation area of 450 m was created at the river's left bank. In 1970, a new plan was conceived and soon executed: digging an additional channel to replace the former inundation area, and using the spoil to build up the remaining strip of land between the straightened bed from the 19th century flood defence schemes and the newly created one. The new channel is called the Neue Donau (New Danube). The works were finished in 1988. Today this is one of the most famous recreational areas in Vienna. (Link: <https://www.wien.info/en/vienna-for/families/outdoor/danube-island>)

Donau Auen National Park. Donau-Auen National Park covers 93 square km in Vienna and Lower Austria and is one of the largest remaining floodplains of the Danube in Middle Europe. It has a rather unique position among the national parks of Europe. The park is situated in the east of Vienna, the capital city of Austria, with a population of 1.7 million. A large percentage of the national park's area lies within the city boundaries of Vienna (22nd district) and within the boundaries of Groß-Enzersdorf, a small municipality in Lower Austria. Settlements and areas of intensive agriculture surround the park.

During the major engineering phase for the Danube between 1870 and 1885, this former dynamic floodplain was disconnected from the main channel by the construction of a flood protection levee. Lateral embankments along the main river channel have severely altered the geomorphic and hydrological dynamics and have impeded the natural sequence of erosion and sedimentation (Hein et al., 2006; Hohensinner et al., 2008). Nowadays, the floodplain can be separated into two subareas (Upper and Lower Lobau) that differ considerably in their ecological characteristics.

Despite the hydrological deficits, the Lower Lobau still harbours a diverse and complex mosaic of aquatic, semiaquatic, and terrestrial habitats, resulting in a high biodiversity. Therefore, the Lower Lobau has been an integral part of the "Nationalpark Donau-Auen" since 1996 and was designated a Natura 2000 area by the EU. Beyond the ecological value, the Lower Lobau plays a central role in landscape water balance, and serves as an important drinking water reservoir

for the city of Vienna. The protection of the floodplains gained in importance compared to the use as a recreation area, which had been the major focus. (Link: <https://www.donauauen.at>)

2.7 Croatia

Zagreb

Projects

Horizon 2020 project **proGIreg (productive Green Infrastructure for post-industrial urban regeneration)**. The project has the objective of demonstrating the integration of NBS into business models which are economically self-sustaining and provide multiple benefits for the economic, ecological and social regeneration of deprived urban areas suffering from the consequences of de-industrialisation. It aims to develop new NBS-orientated economies shared between public authorities, civil societies and industry/SMEs. Within the project, the city of Zagreb acts as a front-runner city where the pilot implementation of NBS (i.e., aquaponics, community-based urban farms and gardens, therapy garden, green walls and roofs, accessible green corridors, local environmental compensation processes) within green infrastructure networks takes place. Furthermore, Zagreb is involved in a number of tasks relevant for the development of a Living Lab (in a post-industrial area in the East of the city) and to promote the results within the framework of trainings (<https://progireg.eu/zagreb>): regeneration of post-industrial area (previous meat processing plant).

URBforDAN (Management and Utilization of Urban Forests as Natural Heritage in Danube Cities) (2018-2021). An Interreg Danube Transnational Programme, the project's specific objective is to foster the sustainable use of natural and cultural heritage resources. This takes place by delivering a change in urban forest management and utilisation of ecosystem services for the inhabitants of cities. A high-quality experience of natural heritage and green tourism for a diverse set of target groups is an intended outcome. Links: <http://www.interreg-danube.eu/news-and-events/project-news/5529>; <http://www.interreg-danube.eu/approved-projects/urfordan>.

The project of the Croatian Science Foundation **CULTUR-ES (Improving green infrastructure planning and management through participatory mapping of cultural ecosystem services)** is an installation research project implemented at the Croatian Forest Research Institute running between January 2018 and December 2022. The goal of this type of research projects is the development of the research group. In this case it involves the project's principal investigator, Silvija Krajer Ostoić, PhD, and two doctoral students. The project deals with the participatory assessment and mapping of selected cultural ecosystem services of different types of urban green infrastructure based on citizen perception. It is applied in the city of Zagreb, the capital city of the Republic of Croatia. In addition, the project collects information on negative perceptions (disservices) of urban green infrastructure. The project also aims to analyse differences in perception and use of different cultural ecosystem services with regard to various types of urban green infrastructure. In this project the cultural ecosystem services addressed are place attachment, aesthetic appreciation, recreation, and educational and cultural heritage services. Based on the focus group results, place attachment and aesthetic appreciation were connected with a higher number of types of urban green space in comparison to educational and cultural heritage services. Qualitative analysis of focus groups serves as a

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base for the development of the PPGIS online survey based on the MyDynamicForest platform in collaboration with HUB. The survey will be released in Spring 2021.

Links to the project: <https://www.sumins.hr/projekti/cultur-es/?lang=en> (in English);

<https://www.sumins.hr/projekti/cultur-es/> (in Croatian)

Project **FORCITY (Citizens and urban forest governance in Southeast Europe: case studies in selected cities)** (2011-2013) was funded by the European Forest Institute within the FOPER II project (2009-2013). The **FOPER II** project aimed at the consolidation of research capacities in forest policy, economics, education and research in Western Balkan countries including Croatia. The FORCITY project was implemented at the Croatian Forest Research Institute which coordinated the implementation of this project in Croatia, Bosnia and Herzegovina, Serbia, Montenegro and Macedonia (now North Macedonia). Researchers from forestry faculties and institutes in these countries collaboratively developed the project, as well as implemented focus groups and regional quantitative survey with citizens in Zagreb, Banja Luka, Sarajevo, Novi Sad, Belgrade, Montenegro and Skopje. This was the first survey of this kind on the regional level that addressed citizen perception of tree-based urban green space and collected their opinion on the governance and management of forests and other green spaces in their cities (Krajter Ostoić et al., 2017). The results showed that citizens view vandalism in urban green space and other negative behaviours of users, especially dog owners, as a major problem in almost all these cities, followed by lack of park equipment (benches, waste bins) and infrastructure (bicycle paths). In all cities, except in Novi Sad, respondents agreed that the amount of urban green space in their city should be increased. They were not very satisfied with the management/maintenance of forests and other green spaces in their cities but were less satisfied with forest management than other green space management. Respondents in all cities very much agreed, with the exception of respondents in Novi Sad who ‘only’ agreed on the need for educational campaigns with citizens about the importance of nature in cities as well as the purpose of raising awareness to prevent negative behaviour in urban forests and other green spaces. Another solution that was very much supported by respondents was the increasing number of communal wardens (*komunalni redari* in Croatian) who are employees of the city administration and whose responsibility it is to monitor rule compliance with regard to urban green spaces and fining those who do not comply.

Three projects focusing on the establishment of educational and recreational trails in Split-Dalmatia County were contracted in 2020 by Croatian Forests Ltd. Company and funded by the Croatian Rural Development Fund. These are the Educational Trolokve trails in the area of the forest office of Brač, the Educational and recreational Musapstan trail in the area of the forest office of Zadar, and the Educational trail in the Gaj park forest in the area of the forest office of Imotski. Foreseen activities include the restoration of existing and building of new trails, development of educational boards, and installing recreational facilities (e.g., gazebos) and furniture (e.g., benches). All three projects are valued each at about 100 000 EUR. They show that the focus of the national forest management company is not only on wood production, which is still the main objective, but also on other forest and green space services such as recreational and educational services. The projects do not have a formal website.

Spurring INovations for Forest Ecosystem SERVICES (SINCERE) (2018-2022). EU-funded Horizon 2020 programme. *Croatian partner*: Nature park Medvednica (located in Zagreb). The project explores new approaches to linking profitable forestry with changing social demands.

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The project's objectives are to find ways to motivate owners and forest managers to support other forest ecosystem services, to raise public awareness of forest ecosystem services and create a database of mechanisms to support them. Local stakeholders play a key role in designing, implementing and evaluating the study through organizational meetings and workshops.

The Pilot Project of Public Institution NP Medvednica will evaluate the health and recreational function of forest ecosystem services in Nature Park Medvednica and will try to express the monetary value of the mentioned functions. NP Medvednica has no entrance fee, therefore one of the mechanisms for investing in forest ecosystem services is imposed donation boxes. The project will test and put in field two donation boxes. Funds collected this way will be invested in infrastructure and new facilities for visitors. The idea is to collect funds for one activity each year. The results will be published on Facebook and the NP Medvednica website and made available to the public. Project link: www.sincereforest.eu

Central Europe Eco-Tourism (CETO) (1/6/2017-31/5/2020). EU-funded – Interreg Central Europe. *Lead partner:* Emilia-Romagna region. Protected Areas, Forestry and Mountains Development Department; *Croatian partners:* Nature park Medvednica, WWF Adria. The project includes 11 partners from Austria (Nature Park Sölktälter, UNESCO Biosphere Reserve Salzburger Lungau), Croatia (Public Institution “Nature Park Medvednica“), WWF Adria – Associate for nature protection and conservation of biodiversity, Italy (Europark Italy – Italian Federation of Parks and Nature Reserves Emilia-Romagna), Hungary (NIMFEA – Environmental and Nature Association), Germany (Europark Federation, Southeastern Biosphere Reserve Rügen), and Slovenia (Regional Development Center Koper, Public Institution Krajina Park Strunjan).

The aim of the project is to establish an innovative participatory approach for sustainable tourism management, which aims to improve the capacity of protected area managers for the sustainable management and use of nature and its values. By implementing pilot activities in eight protected areas (which are also Natura 2000 protected areas), innovative management and monitoring tools will be tested with a special focus on the impact of tourism on biodiversity in these areas. The public institution “Nature Park Medvednica”, located in Zagreb, is one of the eight pilot areas together with WWF Adria that will cooperate in the process of defining the protocol for monitoring the impact of the planned expansion activity in the park – SKI resort on nature and the environment. Project website: <https://www.interreg-central.eu/Content.Node/CEETO.html>

Poboljšanje posjetiteljskog kapaciteta u svrhu održivog upravljanja Parkom prirode Medvednica (Improvement of visitors' capacities for the purpose of sustainable governance of Nature Park Medvednica) (1/3/2015- 30/11/2020). Project funded by ERDF. The goal of the project is the development of the Medvedgrad visitor centre, new cycling paths, signposts within and outside the Nature Park, and the development of various educational and interpretative programmes. The focus of the project is sustainable tourism and visitor management made feasible by developing an Action plan on visitor management in Nature Park Medvednica. Project information (in Croatian): <https://www.pp-medvednica.hr/en/projects/kk-06-1-2-01-0012/>

Gradski prozori u prirodu – unaprjeđenje urbane bioraznolikosti i razvoj zelene infrastrukture (Modernizacija II) (City windows into nature – enhancement of urban biodiversity and development of green infrastructure (Modernisation II) (2019-2021). Project funded by ERDF. *Lead partner:* City of Zagreb. *Project partners:* Public institution Park Maksimir, Biom (environmental NGO), Croatian Union for People with Vision and Hearing and Impairment “Dodir”, Vjetar u leđa (NGO that provides workshops for creative, gifted and talented children). *Associate partner:* Zoological garden of the City of Zagreb, located in Park Maksimir.

The project is implemented in Park Maksimir, which is protected as a monument of park architecture and registered as cultural heritage. The project will develop an educational path and establish a centre for studying protected fauna (Centre for urban biodiversity research, Interpretation centre of protected Croatian fauna, bioforensic lab). Some activities will be related to horticultural renovation, as well as adding urban and park equipment. The goal is to improve the educational, tourist, and hospitality value of Park Maksimir. Eleven newly developed educational programmes will be adapted to people with sensory disabilities. Project information (in Croatian): <http://park-maksimir.hr/o-nama/#projekti>; project brochure (in Croatian): [Link to the project: http://park-maksimir.hr/wp-content/uploads/2019/06/Letak_gradski_prozor_u_prirodu.pdf](http://park-maksimir.hr/wp-content/uploads/2019/06/Letak_gradski_prozor_u_prirodu.pdf)

Velika Gorica

Horizon 2020 project **REGREEN** (9/2019-8/2023). REGREEN promotes urban liveability by fostering NBS in Europe and China using evidence-based tools and improved urban governance accelerating the transition towards equitable, green and healthy cities. REGREEN builds URBAN LIVING LABS (ULLs) as central elements of the project. Three European (Aarhus in Denmark, Paris in France, and Velika Gorica in Croatia) and three Chinese cities (Beijing, Shanghai, and Ningbo) where ULLs will be established differ in size, location, climate and socio-economic conditions as well as in their approaches and scale of application of nature-based solutions. ULLs serve to apply and test novel ideas, methods and tools developed by the project in practice together with the local community – citizens, urban planners, businesses, decision makers and other stakeholders. Link to the project website: <https://www.regreen-project.eu>.

Participatory management of natural resources was a two-year project funded by EU IPA 2012 - Strengthening local partnerships for open government and the fight against corruption in the responsible management of natural resources and co-financed by the Office for Cooperation with NGOs. *Lead partner:* the NGO DOOR; *other partners:* Town of Velika Gorica, ODRAZ-Sustainable Community Development, Association of Towns in Croatia, Green network of activist groups-ZMAG. Some of the results of the project were:

- Two seminars on participatory resource management and community organisation held in Velika Gorica with a view to better management of natural resources;
- The establishment of a working group to improve the management of natural resources in the area of Velika Gorica, whose members are representatives of local associations, local authorities and other relevant institutions. During the meetings, the topic of discussion was on how to improve the management of natural resources within the jurisdiction of the town, primarily by involving citizens at an early stage to work with initiatives, associations or citizens;

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- A study tour to Bologna (Italy), during which the participants had the opportunity to become familiar with models of participative management of natural resources;
- The launch of two advocacy campaigns in the area of Velika Gorica, during which citizens were invited to participate in the process of forest and water management and informed about proper waste management;
- Four regional dissemination workshops "SuDjelujte!" - Organization of participatory management in the local community" held in Osijek, Rijeka, Koprivnica and Zadar.

Link to the project: <http://odraz.hr/en/projects/all-projects/participatory-management-of-natural-resources>

Rovinj

GREEN4GREY Gozdovi za mesta – Šume za gradove (Forests for cities) (1/2014-9/2015). The project aimed at sustainable urban forest management in Celje, Slovenia, and in Rovinj, Croatia. It was funded by the ERDF, operational programme Slovenia-Croatia 2007-2013. Six partners were involved – three from each country. *Lead partner:* City of Celje; *other partners:* the City of Rovinj-Rovigno, Slovenia Forest Service, Society for sustainable development of urban nature from Celje, Public institution Natura Histrica and Istra county. Total budget: 373,126.80 EUR. Project activities included setting up recreational and educational facilities and equipment, workshops on sustainable forest management and forest pedagogy workshops with school children. No available link to the project.

Zadar

The **zeleni otoci (Green Islands)** project, begun in 2013 and ended in 2015, aimed at renovation of the city park Vladimir Nazor in Zadar – new experiences, children’s playground, open air workout areas, environmental education for children in elementary schools. The overall objective of the “Green Islands” project was to contribute to the improvement of the quality of life through the promotion of the environment via joint actions on the preservation and protection of nature in Zadar County and Una Sana Canton. The specific objectives were to preserve, revitalize and promote selected urban green areas in the Municipality of Bosanska Krupa, the Municipality of Bihać and Zadar County and to intensify and consolidate cross-border dialogue through defined actions.

The project totalling 523.417,49 EUR was co-funded by the European Union within the IPA Cross-Border Programme Croatia – Bosnia and Herzegovina 2007–2013. The lead beneficiary of the project in Croatia was the Natura – Jadera Public Institution, while on the Bosnian-Herzegovinian side the lead beneficiary was the Municipality of Bosanska Krupa. Partners in this project were Zadar County, the Municipality of Bihać, the City of Zadar and PLOD Centre – Centre for Promotion of Local Development.

Zeleni otoci (Green Islands) weblinks: <https://natura-jadera.com/projekti/zeleni-otoci>; <https://natura-jadera.com/projekti/zeleni-otoci>; <https://zadar.travel/en/what-s-on/conferences-and-meetings/02-04-2015/ceremony-of-presentation-of-vladimir-nazor-park-arranged-in-the-eu-project-green-islands-vladimir-nazor-park-09th-april-at-11-00-hours#.XmY8LfR7laQ>.

Other UF-NBS projects in Croatia

Horizon 2020 project **CLEARING HOUSE**. Croatian partner: Croatian Forest Research Institute.

Bilateral research project. **Research on social aspects of urban forestry in Croatia and Slovenia** was funded by the Croatian Ministry of Science and Education and Slovenian Research Agency and implemented in 2018 and 2019. It involved research teams from the Croatian Forest Research Institute and Slovenian Forestry Institute. The main result of the project is a literature review of scientific and professional publications regarding tree-based urban green spaces published in the period between 1990 and 2019 in Croatia and Slovenia (Krajter Ostoić, Vuletić, et al., 2020).

2.8 Slovenia

Ljubljana

Projects

URBforDAN (Management and Utilization of Urban Forests as Natural Heritage in Danube Cities) (2018-2021). An Interreg Danube Transnational Programme, the project's specific objective is to foster the sustainable use of natural and cultural heritage resources. This takes place by delivering a change in urban forest management and the utilisation of ecosystem services for the inhabitants of cities. A high-quality experience of natural heritage and green tourism for a diverse set of target groups is an intended outcome.

Links: <http://www.interreg-danube.eu/news-and-events/project-news/5529>;
<http://www.interreg-danube.eu/approved-projects/urbfordan>.

Company programme for urban bees preservation, Ljubljana (2014-ongoing). The EU's Naturvation (Urban Nature Atlas) platform is the source for this UF-NBS project. The private company (non-government actor), BTC, has been engaged in supporting Carnolian Honey bees in Ljubljana. As part of this corporate investment, it has placed beehives at a primary school and given plants for people around Ljubljana to place on their balconies to support urban bees. Therefore, the programme is also geared to benefit citizens and community groups. The urban settings for this project are the external balconies of buildings and primary school, and participatory approaches involve the dissemination of information and education.

Preservation of the native Carniolan honey bee and its complex and incredibly important role in nature is one of the project's main objectives. In 2014, an urban beehive was set up at BTC in Ljubljana, and in 2015 a contest sponsored by BTC for primary schools was held to win a beehive, thus providing melliferous plants to citizens to put on their balconies and support the urban bee.

The project was implemented in response to an EU policy, i.e., the European Green Capital Award (EGCA) - a policy tool the European Commission is using to address urban sustainability challenges, which recognises and rewards local efforts to improve the environment, the economy and the quality of life in cities. The bee project is expected to impact the following: Cultural heritage and cultural diversity; Economic development and decent employment (sustainable development goal, SDG 8); Green space, habitats and biodiversity

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(SDG 15); Health and well-being (SDG 3); and Sustainable consumption and production (SDG 12).

Weblinks: https://naturvation.eu/atlas?search_api_views_fulltext=slovenia; <http://www.btc-city.com/oznaka/43/pomagaj-cebelici-v-mestu>

Cooperation with landowners in protected area – Grounding cooperation with forest landowners to start co-management of the Tivoli, Rožnik and Šiška Hill Landscape Park. (1/5/2018–28/2/2019, 10 months). *Project financing:* the Grant Programme for Protected Areas - Programme Protected areas for Nature and People, carried out by WWF Adria in partnership with Parks Dinarides and other partners from the Dinaric countries. The Programme was financed by the Swedish International Development Cooperation Agency (Sida). *Project leader:* Tivoli, Rožnik and Šiška Hill Landscape Park. Partners: IPoP - Inštitut za politike prostora, National park Una.

The goals of the project are to: establish cooperation between the manager of the Project area Tivoli, Rožnik and Šiška Hill Landscape Park and landowners; define specific groups of landowners; conduct initial meetings and consultations with forest landowners and define basic forms of cooperation with landowners in management; and improve the cooperation between competent institutions and landowners in the project area and develop communication on the management of the project area. Project activities and results include updating the records of landowners and defining typical groups of landowners in the protected area of the Tivoli, Rožnik and Šiška Hill Landscape Park; acquainting landowners with the institutional and legal framework of the Tivoli, Rožnik and Šiška Hill Landscape Park; launching the cooperation with forest landowners; and developing a communication strategy with landowners in the Tivoli, Rožnik and Šiška Hill Landscape Park.

GREEN SURGE - Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy (FP7 project) (1/11/2013-31/10/2017). The project was coordinated by the University of Copenhagen, and one of the Urban Living Labs was established in the city of Ljubljana. Working from the local to the city-regional level, the project aimed to: 1) develop urban green infrastructure as a planning concept for both the integration and promotion of biodiversity and ecosystem services, and adapt it to local contexts; 2) apply an innovative biocultural diversity perspective to develop successful governance arrangements facilitating socio-ecological integration and local engagement in planning urban green spaces; and 3) explore how valuation and real market integration of biodiversity and ecosystem services can facilitate choices in favour of the development of multifunctional green spaces in urban areas. The overall project budget was 7 189 725,60 EUR with an EU contribution of 5 701 836,95 EUR.

Link to the project information and deliverables: <https://ign.ku.dk/english/green-surge/>

European Green Capital Ljubljana, 2016

Link to the information: <https://ec.europa.eu/environment/europeangreencapital/winning-cities/2016-ljubljana/>

EMoNFUr (Establishing a monitoring network to assess lowland forest and urban plantation in Lombardy and urban forest in Slovenia) (LIFE10 ENV/IT/000399; in partnership with Lombardy, Italy) (1/10/2011-30/9/2014). The main objective of the EMoNFUr

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project was to develop a monitoring system for assessing the status of artificial and natural urban and peri-urban forests, and to measure the adaptability of the new lowland forests to climate change. The project also aimed to provide parameters of ecological and environmental relevance, such as plant and animal biodiversity in lowland forests, carbon dioxide sequestration capacity, and the ability to mitigate air temperatures. Specific aims included: preliminary monitoring of lowland urban and peri-urban forests in representative sites in Italy (Lombardy) and Slovenia (Osrednjeslovenska region); mapping out a permanent monitoring network; establishing the first general proposal for a harmonised European monitoring network; analysing the ecosystem services offered by artificial and natural urban and peri-urban lowland forests in Lombardy and Osrednjeslovenska; and building local awareness on the importance of monitoring lowland forests and understanding their role in mitigating climate change. The EMoNFUr project demonstrated that urban and peri-urban forests play a significant role in reducing the effects of climate change at the urban and, in particular, at the peri-urban scale, namely with respect to heatwaves, air pollution mitigation and rainwater storage.

Link:

https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4015.

Ljubljana Connects, Ljubljana (LIFE10 NAT/SI/000142 project) (1/1/2012-31/8/2016). The aim of the project was to improve the transitivity and connectivity of Natura 2000 sites, by restoring the functionality of the Ljubljana River corridor (and the flow regime) connecting two Natura 2000 sites, i.e. Ljubljansko barje (Ljubljana Marshes) and Sava–Medvode–Kresnice. The project goals will be achieved by removing fish migration barriers, improving the water regime and thus restoring habitats, by improving water infrastructure, water management, and by establishing hydrological monitoring. The target fish species, for which the habitats are to be improved, are Danube roach, Danube salmon and striped chub.

Initially, the river engineering measures will include the sealing of the weir located before the railway bridge over the Ljubljana River in Zalog. Hence, under dry atmospheric conditions, the water level will not decrease and the conditions in the oxbows upstream of the Ljubljana will improve. The fishways at the dam at the Fužine Castle and the sluice gate at the Ambrose Square will be refurbished and renovated. This will enable the migration of fish, which is now severely impeded. The existing chain lift mechanism enables a rather approximate control of the gate, and, consequently, of water flows and levels, resulting in the instant lowering of the water levels upstream. Upgrading or improving the gate will allow a finer degree of control of the Ljubljana water levels, especially during low flows and droughts. This is vital since the maintenance of the right level of the Ljubljana affects the entire water regime of the Ljubljana Marshes.

The water regime in the Ljubljana River and its tributaries affects the Natura 2000 habitats and the activities related to fisheries, tourism navigation, drainage/sewerage system, sound agriculture and, eventually, the entire infrastructure. During low water levels excessive drainage and subsidence of soil occur, deteriorating the state of the entire infrastructure. In essence, the project is multipurpose and multifunctional. The ‘Ljubljana Connects’ project connects the Natura 2000 and other aforementioned activities. The total budget is €1.19 million, with the EU

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funding almost half. Links: <https://oppla.eu/casestudy/19461>; <http://ksh.fgg.uni-lj.si/ljubljanaconnects/ANG/default.htm>

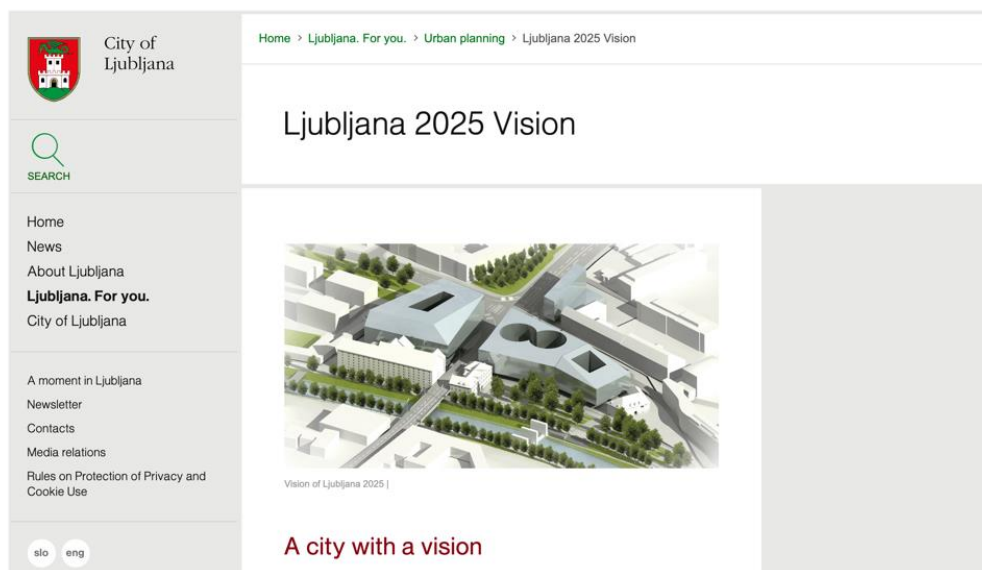
Celje

GREEN4GREY Gozdovi za mesta – Šume za gradove (Forests for cities) (1/2014-9/2015). The project aimed at the sustainable urban forest management in Celje, Slovenia and in Rovinj, Croatia. It was funded by ERDF, operational programme Slovenia-Croatia 2007-2013. Six partners were involved – three from each country. *Lead partner:* City of Celje; *other partners:* the City of Rovinj-Rovigno, Slovenia Forest Service, Society for sustainable development of urban nature from Celje, Public institution Natura Histica and Istra county. Total budget: 373.126,80 EUR. Project activities included setting up recreational and educational facilities and equipment, workshops on sustainable forest management and forest pedagogy workshops with school children. No available link to the project.

Other UF-NBS projects in Slovenia

Mediterranean Forests for All (SYLVAMED) EU co-funded MED Programme (1/9/2010-31/8/2013). *Lead partner:* CTFC, Spain. *Other partners:* from Slovenia (Slovenia Forest Service), France, Italy, and Greece.

The project focuses on the development of new payments for ecosystem services (PES) in private forests, specifically compensation for the production of drinking water, and the provision of social services (tourism and recreation), including non-wood forest products (e.g., mushrooms, honey), in PES schemes. (Link to the information in Slovenian: http://www.zgs.si/zavod/mednarodni_projekti/zakljuceni_projekti/sylvamed/index.html; link to the project on the EFI website: <https://efi.int/projects/sylvamed-mediterranean-forests-all>)



‘Ljubljana 2025 Vision’ is the city’s leading urban planning instrument for the future.

2.9 Serbia

Belgrade

Several NBS projects have been undertaken in the city of Belgrade and are currently underway.

Linear Park, Belgrade. The co-creation of the city's new Linear Park: a green, hybrid space that will bring nature, art and science to the heart of the Serbian capital. The project's objective is to relocate the railway system around the Kalemegdan fortress and convert the traffic areas into green areas for public use. In accordance with the decision of the Assembly of the City of Belgrade, starting in September 2018 the Directorate for Construction of Land and Construction of Belgrade initiated the development of the Detailed Regulation Plan (PDR) for this area, which is currently being developed by the Urban Institute of Belgrade. The area of the Linear Park in Belgrade includes the corridor of the old railway within the territory of the Stari Grad municipality and the Palilula municipality, from the "Concrete Hall" to the Pancevo Bridge, spanning 4600 m.

The City of Belgrade has made a strategic decision to plan this important space in a democratic, open and participatory manner. It has launched a series of actions that should engage citizens and various experts at an early stage of the drafting of the PDR. These processes are supported by the professional association CEUS, which together with the City of Belgrade participates in the implementation of the international research and development project CLEVER Cities. The theme of this project is co-creation in city planning, with the application of a living laboratory approach and nature-inspired solutions. Links: <http://bellab.rs>; <https://clevercities.eu/belgrade>

Revitalization of the lake at Trešnja using a system of floating islands. Thirty years ago, the Trešnja forest complex was one of Belgrade's favourite areas for excursions and picnics. Today, the lake in this locality is heavily polluted due to the construction of weekend settlement without sewerage systems. The entire complex is neglected and effluents from septic tanks have filled the lake with wastewater for years. The main objective of this NBS project is to offer environmentally friendly, efficient and economically cost-effective solutions for the treatment and revitalisation of the polluted lake. Thanks to previously conducted research, the installation of a system of floating islands is expected to be very effective in removing various pollutants, inevitably leading to an improvement in the ecological status of the lake's water. This example of a good practice should be appreciated by authorities and other stakeholders so that floating islands will continue to purify the contaminated water until the discharge of polluted water in the lake will become a resolved issue. The final result has been the merging of floating islands with the surrounding landscape. Water analysis showed that the floating islands enabled the removal of various pollutants from the contaminated water. Project implementors were: the Institute of Forestry, Belgrade, City of Belgrade - Belgrade City Administration – Secretariat for Environmental protection (2018 - 2020). Link: <https://www.researchgate.net/project/Revitalization-of-the-lake-at-the-locality-of-Tresnja-by-the-system-of-floating-islands>

Revitalization of Topčiderka river by biological systems for purification of polluted waters. In larger settlements, such as the city of Belgrade, municipal wastewater is often mixed with industrial wastewater causing enormous damage to aquatic flora and fauna. Such action

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also prevents the use of surface water for recreational purposes, damaging the environment of the river valley and more. Recognising the aspirations of an environmentally conscious society to perceived planning, management and protection of water as one of its main tasks, in 2014 the Secretariat for Environmental Protection of the City of Belgrade granted a tender Project "Revitalization of Topčiderka river by biological systems for purification of polluted waters" to the Forestry Institute in Belgrade. The main objective of the project is to offer an environmentally friendly, efficient and economically viable solution for the treatment and rehabilitation of polluted urban river flows. A biological pilot system for the treatment of polluted water was set up on the shore of the Topčiderka river within the nursery of the State Enterprise for forest management "Srbijasume" Belgrade, FE "Belgrade". The aim of using the pilot system is to find suitable models of biological systems that could be used for the water purification of other rivers, canals, ponds and lakes in the future. Results showed that the proposed system of floating islands is a technology that allows to achieve high ecological standards along with the conservation and sustainability of natural resources. Because it does not require major investments, over the long term the proposed system generates quantitative and qualitative economic and social effects, among others, thus it is also economically acceptable.

The city of Belgrade has many potential areas for establishing the floating islands system that can help to restore and maintain the physical, chemical and biological integrity of water. Project implementors: Institute of Forestry, Belgrade, City of Belgrade - Belgrade City Administration – Secretariat for Environmental protection (2014 - 2016). Link:
https://www.beograd.rs/images/data/98e470b6829e9ce1a59ff91b9a926ad2_1251546056.pdf

URBforDAN - Management and Utilization of Urban Forests as Natural Heritage in Danube Cities. URBforDAN is an Interreg project designed to impact urban forest management and the utilisation of ecosystem services. The ecosystem services are provided by pre-selecting areas in seven project partner cities. The project is intended to keep the current image of urban forests and to guarantee that forest areas become places of socialisation, relaxation, recreation and education. URBforDAN aims to improve cooperation between key actors to resolve conflicts and improve the management of urban forests. At the same time, it seeks to enrich "green tourism" in the Danube Cities through new and improved services and products, which are accessible on 700 ha of urban and peri-urban forests. Avala mountain, a protected natural asset, is the project's area of focus in Belgrade. The partners will enrich and equip this area as well as the area of Šuplja Stena, proposing specific activities and/or urban equipment (signposts, benches, tables, haylofts, and information boards). Link:
<http://www.interreg-danube.eu/approved-projects/urbfordan>

Green Walls - Reducing GHG Emissions and Increasing Energy Efficiency, is a project awarded by the UNDP Development Programme: CLIMATE SMART URBAN DEVELOPMENT INNOVATION CHALLENGE. In the municipality of Čukarica, Serbia, there are many housing estates and industrial drives, and traffic infrastructure is developed along few main corridors. With regard to climate change, the dense residential estates, traffic frequency and noise, and microclimate conditions differ. Temperature, gas emissions and energy consumption have further increased in these localities. Therefore, hot islands are formed with the clear effects of GHG.

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In collaboration with the municipality of Čukarica, the most appropriate residential or office building will be selected for green wall construction. On the selected building, an investigation will be conducted of all ecological and technical conditions for forming green walls, such as: climate and microclimate conditions, degree of air pollution and GHG emissions, orientation of the building in relation to daylight hours, the direction of prevailing winds, shadows of neighbouring buildings, and presence of underground water. Technical conditions include a support structure for the green walls, substrata for plant growth, and an irrigation system supported by underground water and regular maintenance.

Plant species are the most important ingredient of the green walls project. These plants will be selected based on their morphologic and decorative characteristics and those most appropriate for energy efficiency and to absorb GHG emissions. Plants with these capabilities are not tall, have dense formations, easily propagate, store water, and have shallow and thick root systems. The plants will be grown in the laboratories, greenhouse and nursery of the Faculty of Forestry. Substrata are important for green wall functioning. The green wall will be constructed using geothermal materials which allow aeration. Irrigation will be supported by underground water; this system is long lasting with the appropriate maintenance.

2.10 Italy

Milan

Parco Nord Milano (PNM) is one of Italy's most relevant UF-NBS projects ever realised. Located on the eastern-northern outskirts of Milan in the Lombardy region, PNM is a big metropolitan park covering 790 ha, recovering green areas which once were industrial or uncultivated lands. In 1975, PNM was officially recognised as a regional park and incorporated seven municipalities. Its urban green infrastructure consists of large woodlands, meadows, hills, stretches of water bodies, tree-lined roads, and flowerbeds as well as other natural elements that were once industrial, agricultural or uncultivated lands. The park is maintained, cleaned, and supervised on a daily basis, rendering it a safe place for various types of recreation in order to meet the needs of citizens.

Site management focuses on nature-based approaches to attract public benefits and deliver ecosystems services. The consolidation of the Metropolitan City of Milan in 2015 led to the creation of a single metropolitan park uniting PNM and South Milan Agricultural Park. PNM is a Regional Public Law Entity and part of the Protected Areas System of Lombardy. The principal UF-NBS actions in the park are: forest plantations, water retention basins to prevent flooding, ecological corridors, annual implementation of new plants and trees, and social allotments.

For PNM authorities, nature in the park is considered a connected framework and strategy for addressing issues of connectivity/climate change. Connectivity is ensured by identifying transition zones between built-up urban and peri-urban areas. In fact, PNM is part of a green belt system to ensure continuity within the ecological network. The principal planning instruments that secure the ecological network are the Regional Ecological Network (RER) and Provincial Ecological Network (REP).

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The PNM project exists thanks to a synergistic participatory process of a variety of actors that contribute knowledge from different disciplines. These include park planners and authorities, associations, administrative authorities, the agricultural sector, the municipalities comprising the park, citizens, the Municipality of Milan, technicians who educate and support citizens/groups who help maintain the initiatives as well as undertake monitoring activities, and landscape architects who work with park authorities in planning and management. Aside from the environmental and recreational events held in the park throughout the year to foster appreciation for biodiversity and participatory support, the park organises a rich environmental education programme for the kindergartens, elementary and intermediate schools of the Municipalities. (For weblinks to PNM and the Lombardy region see Appendix 1: Grey Literature)

Bari

L. Braille Public Garden is a local UF-NBS project in the city of Bari (Apulia region). The main objective for creating the garden was to renovate the urban environment of a derelict area. Before its renovation, this uncultivated public urban space owned by the Municipality of Bari had been illegally used as a parking lot. The public garden covers an area of approximately 9500 m² with vegetation consisting of numerous trees, shrubs and plants maintained by a state-of-the-art remote control irrigation system. The project specifically addresses the issues of climate change, wellbeing and social cohesion; the categories of ecosystem services provided are: 1) Cultural: physical wellbeing, recreation and social cohesion; 3) Supporting: habitat restoration; increased biodiversity; 4) Regulating: mitigation of the urban heat island; reduced noise, air and light pollution; and 3) Provisioning: cost-savings and runoff mitigation.

L. Braille Public Garden was entirely financed by the Municipality of Bari. It was implemented thanks to a synergistic participatory process of public administrative authorities, project designers and technicians with knowledge of urban landscape planning, irrigation, lighting, and computer systems. The principal stakeholder is the Municipality of Bari, including the Parks and Gardens Division which is responsible for monitoring, managing and implementing the garden's vegetation. At city level, the Preliminary Planning Document (DPP) is the planning tool applied for generating sustainable urban development approaches through a strategic planning process; the plan is part of the General Urban Plan (PUG). The divisions involved are the Department of Planning and Private Building, the Department of Infrastructure, Roads and Public Works, and the Gardens Sector of the Municipality of Bari. The 'Urban Civic Networks' civic association is the stakeholder that organises events and promotes the garden. L. Braille Public Garden continues to have a strong impact on local citizens, fostering social cohesion and biocultural diversity.

Link: 'Reti Civiche Urbane' Association: <https://www.bariinnovazione sociale.it/reti-civiche-urbane/carrassi-san-pasquale-mungivacca-bari-rcu>

Turin

Laghetti Falchera ('Falchera Lakes') is a green lung of about 430,000 m² in the northern area of Turin. It was completed and opened to the public after almost five years of work and is one among several UF-NBS projects completed by the City of Turin. The area was redeveloped

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with the two-fold objective of increasing public green spaces for the local population and for enhancing the naturalistic value with the presence of quarry lakes, which now represent a consolidated ecosystem. The types of interventions were decided upon in agreement with the committees of the territory and citizens.

The recovery and environmental redevelopment of the area began with the reclamation of the lake from waste materials and the removal of illegal gardens in December 2015. The assignment of the new gardens, in June 2018, represent the first step of this ambitious project: 122 individual gardens, of about 100 m² each, fenced with a plasticised metal mesh, equipped with an irrigation system, lighting, common facilities and a shed for storing tools. In addition, there are about 50 collective/associative gardens divided into two sub-areas of about 2500 m² each. The urban gardens were integrated in the “Turin City to Cultivate” project, aimed at introducing multifunctional urban agriculture and forestry.

The Laghetti Falchera park features spaces for aggregation and socialisation with playgrounds and areas for sports activities and walking dogs, benches, tables, and about 500 newly planted trees. In proximity to the large lake, a beach was created which allows boating activities. In this area, the construction of a small club house and pier is planned. The eastern part of the lake provides favourable conditions for the creation of a wetland and, therefore, a naturalistic habitat will be developed for bird watching and vegetation. The project includes the construction of an exercise path with equipment and rest areas with benches and bike racks. The entire area is accessible via a system of connections and paths inside the park. Nature trails were built using natural stabilised material. The park also acts as a large-scale cycle link between the cycle system of northern Turin and two other cycle nodes. The total cost for redeveloping the Falchera lakes is approximately €5,600,000.

Link: <http://www.comune.torino.it/verdepubblico/2015/altrenews15/approvato-progetto-laghetti-falchera.shtml#>

UF-NBS projects in Italy are also exemplified by the ongoing case study in Turin currently underway in the EU’s Horizon 2020 Research and Innovation programme **proGIreg (productive Green Infrastructure for post-industrial urban regeneration)**. The proGIreg proposal relates to part b) “Nature-based solutions for inclusive urban regeneration (2017)” of the topic “Demonstrating innovative nature-based solutions in cities” (SCC-02-2016-2017). The actors taking part for Turin are the Municipality of Turin, the Polytechnic Institute and University of Turin. Turin will be involved in introducing NBS in the form of collaborative vegetable gardens, pollinator-friendly areas, and green roofs and walls to the post-industrial ‘Mirafiori Sud’ area. The project works on different sectoral policies, including urban regeneration, social and active inclusion, environment and green planning, and economic development and support to innovation. The goal is to provide green and blue spaces that residents can visit (e.g., access to a river bank, a renatured square) and to engage in physical activities. Specifically, the NBS are as follows:

- NBS 1: Leisure activities and clean energy on former landfills
- NBS 2: A 2000-m² test area “New soil and plant species for urban forestry” in Parco Sangone;
- NBS 3: An 8-ha development area for urban farming and gardening involving disadvantaged groups;

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- NBS 4: A small aquaponics testing installation area to be selected during the co-design phase, implemented in cooperation with experts from a European partner country involving local communities for future replication;
- NBS 5: Green walls and roofs, urban gardens in deprived neighbourhoods, with active inclusion of specific target groups (including education in schools and collective gardening projects involving refugees);
- NBS 6: A new greenway and cycling corridor along Sangone river, which is connected to the entire Turin metropolitan cycling network and links post-industrial private areas with public areas;
- NBS 7: New environmental compensation instruments, connected with the environmental assessment and compensation of big events and the realisation of a “green business network”;
- NBS 8: Pollinator friendly green spaces to encourage bee-keeping and honey production as well as bee monitoring, involving local communities in citizen science projects.

The NBS will also have a positive impact on the physical health, mental wellbeing of people from adjacent neighbourhoods as well as promote local identity and increase community cohesion. By improving the urban environment and creating new opportunities for the local economy, these NBS will help to reduce inequality and social exclusion. The enhanced sense of local identity and citizen ownership within the urban areas to be redeveloped through NBS will help to reduce crime rates and associated security costs through promoting increased local accountability and stewardship of the urban environment by the local community. The business models for industry and social entrepreneurship which will be developed for creating and managing NBS will open ways to escape marginalisation and poverty for residents and immigrants to deprived urban neighbourhoods.

The ultimate aim through effective communication and dissemination work is to increase the uptake of the project’s NBS models and approaches among key target audiences, including local citizens, civil society, policy-makers, academia and the private sector. Replication workshops will be organised for city staff, the private sector, civil society and other relevant stakeholders from both within and outside of the project to facilitate knowledge transfer, exploitation and create a community of practice. The proGIreg team will create the “Nature-based urban regeneration” Massive Open Online Course (MOOC), which will be fully open-access and available via edX. Themes to be covered in the videos will range from the co-design of NBS to their implementation and management. The principal lesson learned from the project is that NBS have huge potential to address technical, social and economic challenges and to make urban transformation work with and for citizens.

proGIreg links:

www.progireg.eu;

https://progireg.eu/fileadmin/user_upload/Deliverables/D4.1_proGIreg_CNR_2019-12-23.pdf; <https://cordis.europa.eu/project/id/776528>; <https://oppla.eu/casestudy/20114>

2.11 Poland

Łódź

Complex of three parks as a site of the International Horticultural Exhibition 2024, Łódź.

The International Horticultural Exhibition 2024 in Łódź will feature two parks – 3rd May Park historic park, and Baden Powell Park – along with the neighbouring green square in the city centre, covering altogether more than 77 ha. The exhibition's title "Nature of the City" expresses the desire for a city as a pleasant place to live in, work, rest, entertain and relax. The exhibition will not only concern revitalisation (urban revival) but also the shaping of the urban landscape and the use of potential green spaces in cities. Currently, these parks and the green square are separate green spaces, but in 2024 exhibitions and floral constructions will cover these three green spaces and will form one coherent exhibition site.

The theme of the exhibition focuses on the use of nature for the development of the city and for improving the quality of residents' life. For this purpose, the principle UF-NBS actions will include: increasing the quantity and improving the quality of green spaces in the city; new plantings of trees, decorative shrubs and flowers; the creation of green walls and green corridors, as well as of water reservoirs, small ponds, and fountains. UF-NBS typologies are green urban areas, gardens, parks (i.e., amenity green spaces); hedgerows; ornamental trees and shrubs; and flower installations. Expo organisers focus on a whole range of cultural services – aesthetics, entertainment, heritage and interpersonal integration. In their vision, they emphasise the importance of revitalisation, social participation and involvement. However, other ecosystem services are definitely lacking, especially those related to providing habitat for wild animals and plants, improving the microclimate, air purification, noise attenuation or water retention.

The stakeholders involved in the project include city authorities, who are responsible for organizing the exhibition; regional authorities – the Marshal of the Łódź Region; the Polish Nurserymen Association; individual citizens and residents associated with the Nie dla Expo ('No to Expo') association who expressly oppose organisation of Expo 2024 in the proposed site. Other stakeholders are the City Office of Łódź, public/private institutions, park planner and authorities (e.g., expert dendrologist of the Polish Society of Tree Surgeons), as well as landscape architects and technicians for park support and maintenance.

The global budget of the exhibition assumes the expenditure of approximately EUR 100 million. The Expo's finances are constructed based on the city's budget with the support of the Polish government, private investors and potential EU funding. The EXPO 2024 budget may be supported by EU subsidies. Co-financing of projects related to environmental protection and urban regeneration falls within the European Parliament's priorities for the coming years.

It is likely that with the Expo the parks will cease to perform their current functions – with new paved paths and exhibition buildings part of trees will be cut down, parks will lose their unique character and biodiversity (while biodiversity should be a cornerstone of NBS). Therefore, the opposite of the term 'renaturing' would occur, because this exhibition is related to reduction of park biodiversity and "wildness" and the interruption of ecological connectivity.

Krakow

At the request of the Municipality of Krakow, the Bureau for Forest Management and Geodesy started to develop the green space programme “Poviat Programme to increase the forest cover of the City of Krakow for 2018-2040” in 2016, based on Resolution No. XLIV/796/16 of the Krakow City Council. The Programme establishes the rules and conditions for increasing the forest area in the Municipality of Krakow at a level of no less than 8% of the city area by 2040. The resolution defined the priority area of activities related to increasing forest cover in the City of Krakow. This objective of the strategic Programme is to build and bring a high-quality sustainable natural environment to quality standards, with particular emphasis on improving air quality and reducing noise levels; one of the key measures is to double the forest area in the city. Conclusions were adopted from the "Directions for the development and management of green areas in Krakow for 2017-2030", prepared by the Department of Environmental Management of the Municipal Office of Krakow. The analysis covered the local spatial development plans and the Study of the Conditions and Directions of Spatial Development of the City of Krakow (Resolution No. XII/87/03 of April 16, 2003, amended by Resolution No. XCIII/1256/10 of March 3, 2010, amended by Resolution No. CXII / 1700/14 of 9 July 2014). The Office of Forest Design and Geodesy, Branch in Krakow, on April 26, 2017, began cooperating with the Regional Directorate of State Forests in Krakow to implement the Poviat program and conduct social consultations for the City Greenery Board in Krakow. As part of new plantings related to the implementation of the Programme, native tree species were selected that are compatible with the habitat based on the applicable rules of silviculture.

Documentation was prepared for the Programme to increase forest cover for the years 2018-2040 and refers to the land located within the entire range of the Municipality of Krakow. A total area of 1630 ha (including reserve land, 200 ha) was designated for reclassification into forest land (574 ha) or for afforestation and reclassification for Ls (Forest) use in the longer term. In total, about 856 ha of land were selected for afforestation supplementing the initial succession in the Programme for increasing forest cover. Afforestation and other activities related to this process are planned in four stages. Implementation of the Programme should be completed by 2040, and forest cover should increase to an area of not less than 8%. Afforestation tasks should be carried out on land obtained with the funds made available by the City of Krakow and take into account possible afforestation by private owners (also with the use of natural succession). During the field work, samples were taken for chemical analyses and forest habitat and soil types were determined. On the results, afforestation plans were developed, indicating native tree species that will be used for future afforestation.

The redoubling of the forest area in Krakow by 2040 would represent a big step for green areas in the city. After years of neglect and underinvestment in green space, Krakow has quickly caught up: allocation of 3% of the Municipal Budget to green space set a precedent in Central Europe, stemming from the unanimous will of residents, councillors, and the Mayor. From pocket parks to the country's largest green investments, Krakow's green space has quickly become a cause for pride for Krakow's citizens. Furthermore, generally accessible municipal green resources are expanding at the fastest rate in Poland. In 2016 the Municipality purchased land worth 9,200,000 EUR for green spaces – 15 times that in 2014. A true green revolution in this part of Europe. For such an impressive green space project and its efforts in urban

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infrastructure management, Krakow has been proposed to apply for the “European Green Capital Award 2022”.

Poznań

Green Wedge System. The UF-NBS in the city of Poznań currently constitute around 27% of the city's surface area, most of which is taken up by communal forests (2,580 ha) and parks (over 526 ha). City authorities have been focusing on effectively managing and revitalising the green wedge system while creating new sites in spite of the limited available space. In recent years, 18,000 trees have been planted solely alongside roads. Efforts have been made to prioritise green space over concrete areas through transitional elements, such as containers with various seasonal flowers, to improve the urban environment. Parking places in sealed areas have been transformed into green areas, e.g. the square at Poznań City Hall and at Kolegiacki Square, which have improved soil quality and climatic and water conditions. In the city centre, a new park – Stare Koryto Warty Park – has been built on a 3.5-ha area that previously consisted of undergrowth, which includes a playground, an exhibition space, an amphitheatre and fountains. On the Warta River, four seasonal beaches have been created where local citizens can relax in summer. Community gardens (a tradition covering 3.1% of the city) have also been set up, with the aim of maintaining resident participation. After a pilot stage to build gardens in schoolyards, the city authorities now intend to involve pensioners as well. During the Programme the authorities provide inhabitants with plants and gardening tools. City authorities are also planning to identify more areas available for residents to develop gardens. The public bicycle system has been upgraded with new public bikes and additional cycling routes that supplement public transport with the ultimate aim of having a complex and comprehensive cycling route system throughout the city.

The city's own budget provides the largest financing share for green investments, followed by the national fund for environmental protection and EU funding. EU funding is used for a current development project involving a 14-ha park and the purchase of native plants for the park.

A few lessons can be learned from this UF-NBS case study: The main driver for implementing UF-NBS is the need to keep residents in the city and to combat air pollution and climate change; when there are financial possibilities available to inhabitants, the inhabitants suggest and then choose the projects, e.g. which projects are intended to improve the city's environmental quality; there is the need to have more dialogue with the other responsible sectors, showcasing the multiple benefits of UF-NBS while at the same time employing technical solutions to enable UF-NBS. (Link: <https://oppla.eu/casestudy/19452>)

Wroclaw

Demonstration projects to be developed in Olbin neighbourhood, Wroclaw. In this part of the city of Wroclaw, the courtyards between apartment buildings are currently used as parking or empty spaces. In collaboration with the GrowGreen project, a discussion was held in June 2019 on the progress of developing demonstration projects and strategies for UF-NBS and to find opportunities to share knowledge and experiences to resolve this issue. The courtyards will be linked with a ‘green street’ with more planted trees. The impacts of the UF-NBS on temperature, stormwater, biodiversity and other parameters will be investigated by comparing

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monitoring data collected before and after their installation. The project is well advanced, and local citizens have co-created the designs for their UF-NBS with the GrowGreen team. On-site monitoring systems have been running to collect information before the solutions are put in place. With the help of local residents, UF-NBS have been designed to store rainwater, provide shade, and increase biodiversity. They will also include children's playgrounds and community gardens for people to socialise.

Work will continue on implementing the demonstration projects and monitoring their impacts, as well as on updating or developing UF-NBS strategies, with the support of the GrowGreen partners. The lessons learned will feed into activities to build the capacity of other cities and replicate the project outcomes internationally. (Links: <http://growgreenproject.eu/growgreen-cities-plan-collaborations-wroclaw>)

2.12 Finland

Helsinki

New UF-NBS projects

Meijän polku (Our path) is a large cross-sectoral collaborative programme in central Finland, initiated in 2017. It is based on the voluntary involvement of active members, including professionals from the fields of health care, physical education, educational establishments and National Institute of Parks & Wildlife, and supported by organisations like Central Finland Health and Wellbeing EcosystemKeHO, Central Finland Health Care District, Central Finland Sport Federation, Jyväskylä University of Applied Science and University of Jyväskylä, and the LIKES Research Centre for Physical Activity to encourage people to improve their health through the use of forests, including urban forests, national parks and other large dedicated outdoor recreation areas. This holistic approach to public health focuses on increased physical activity, adequate rest, contact with nature and community well-being. It aims at gradual but long-lasting behavioural change. The operational goals vary for different population segments (active/sedentary, young/old, healthy/chronically ill). Services, activities and tools are available free of charge for individuals and groups, tailored to all seasons and weather conditions. (Link: <https://www.meijanpolku.fi>)

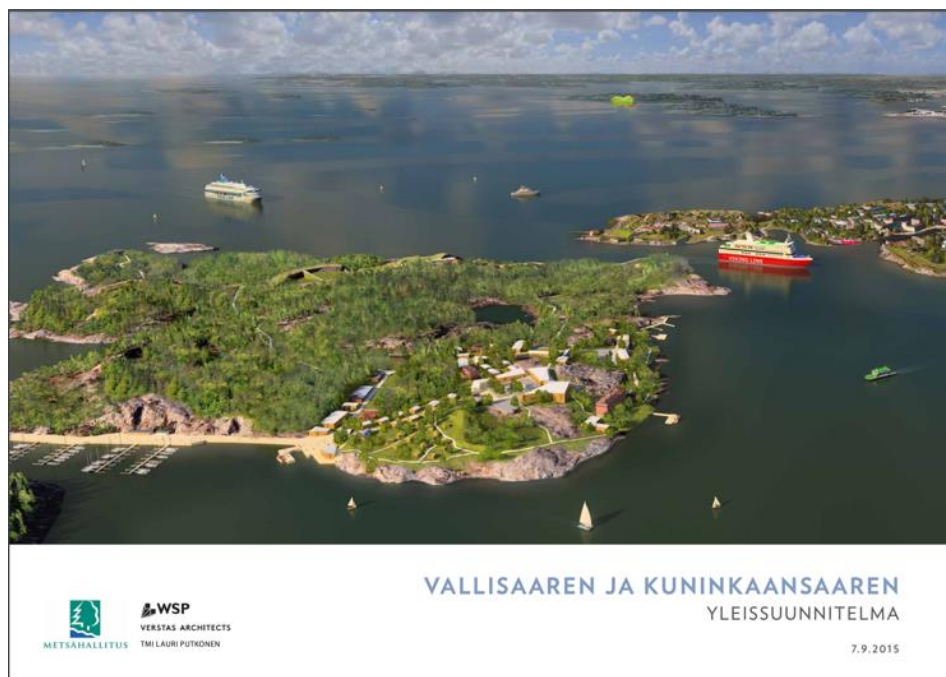
NATTOURS – sustainable urban nature routes using new IT solutions. The NATTOURS project has improved public recognition of nature-based tourism and recreation possibilities in Tallinn and Helsinki by developing sustainable nature tourism attractions in both cities and a joint web portal with applications for nature tourism and education. To support the city partners with this aim, several methods were utilised to gain a better understanding of the ecosystem services in these cities and several specific sites, and to get to know more about visitors, their expectations and how their experience at the sites can be maximised. At project termination, a new common web portal and mobile application for nature tourism and education in Helsinki and Tallinn was built.

Nature Trail “The Lap of nature” was built in the NATTOURS-project for Old Town Bay (Vanhankaupunginlahti), Helsinki. The trail is accessible for wheelchair users with only very small slopes. The disabled and elderly were taken into special consideration when designing

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the attractions. It is also widely used for environmental education. (Link: <https://citynature.eu/en>)

Vallisaari, the Valli Island located 20 minutes by boat from the Market Square in Helsinki is part of the UNESCO World Heritage Site of Suomenlinna and is a nature reserve. Vallisaari and Kuninkaansaari are enchanting destinations for outings, just next to the Suomenlinna fortress. The islands have remained almost in a perfect natural state. In 2013, Metsähallitus Parks & Wildlife Finland started a project to open the islands to visitors and thus this unique nature tourism destination opened in 2016. The islands are managed by Metsähallitus, Parks & Wildlife Finland, Coastal and Metropolitan Area, but in collaboration with volunteers who also look after the nature on the island. In addition, convicts participated in the repair work. The Vallisaari master plan of land use looks further into the future, ensuring that Vallisaari responds to the call to promote the health and well-being of citizens through mobility in nature, offers employment and economic opportunities, increases tourist attraction of the Helsinki archipelago and that the islands retain their most valuable appeal, i.e. natural and cultural values. (Link: <https://www.nationalparks.fi/en/vallisaari> and <https://vallisaari.fi/en>)



Vallisaari Master Plan, Finland.

Kintterö health forest – A plan supporting health and wellbeing for the surroundings of the central hospital of Päijät-Häme located in Lahti. The plan and design of Kintterö Health Forest has been conducted as a landscape architect diploma thesis. The site is located in Lahti in the surroundings of the Central Hospital of Päijät-Häme and is dominated by Salpausselkä recreational forest. The health forest aims to provide an outdoor environment that supports the Central Hospital and the health and wellbeing of its customers. The design and the activities of the health forest support rehabilitation, help people to master emotions, relax and cope with a difficult life situation and promote social cohesion. Kintterö Health Forest consists of two different parts, “the Oasis of Experiences” and “the Forest Path”, that are united by a shared gate. The gate symbolises transition and creates a link between the forest and the hospital. “The

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oasis of experiences” is an accessible area that helps people to easily get in contact with nature. “The forest path” focuses on individual recovery, with places to stop, relax and refocus along the route.

Kintterö Health Forest has the possibility to act as a pioneering example of hospitals that utilise forests and nature in Finland, combining the knowledge of different disciplines and the potential of its surroundings. The health forest concept brings together different fields of knowledge, such as forestry and psychology. To use the health and wellbeing supporting potential of forests to its full extent, the knowledge of landscape architects is also essential, as the design of the areas plays a central role for the outcome.

European Green Capital 2021 Lahti has a shared vision of a bold environmental city and commitment to ambitious environmental goals; these are to: cut CO₂ emissions by 80% from the 1990 level by 2025; be a carbon-neutral city by 2025; be a waste-free and complete circular economy city by 2050; protect nature and valuable freshwater and groundwater resources; and increase all sustainable urban mobility modes: walking, cycling, public transportation. In 2021 the municipalities in the Lahti region as well as the companies, communities and citizens in all of Finland will gather to build a more sustainable future (<http://greenlahti.fi/en>). As a Green Capital, Lahti has especially taken its ecosystem services into account in its land use planning. (Link: <http://lahdenvuosi.fi/yleiskaavaselostus/lahti-vuonna-2025-tarina/kestavasti-kasvavalahti/ekosysteemipalvelut>)

Autoimmune Defense and Living Environment (ADELE) was a strategic research opening a project funded by the Finnish Funding Agency for Technology and Innovation (2015-2018). The ADELE-project produced knowledge to facilitate the development of solutions that balance and enhance the function of immune systems. One of the research outcomes was that greener play areas boost children’s immune systems. The aim was to develop strategies for the prevention and cure of immune-mediated diseases, such as allergies, asthma and type I diabetes. According to the ADELE-project, one solution could be to expose children living in urban cities to diverse microbes that are healthy for young immune systems. This can be done by installing the forest floor harvested from the real forest to the kindergarten yards in urban cities. Nowadays, one in five people in developed countries suffer from an immune-mediated disease, and approximately 100 million people in the European Union have such diseases. The costs of these diseases have been estimated to be more than 100 billion EUR annually. Collaborators include specialists working in the private sector, the Natural Resources Institute Finland, University of Oulu, University of Turku, Charles University in Czech Republic, Kansas State University, University of Massachusetts Amherst, University of Florida and the University of Texas.

Currently, the ADELE-project targets the creation of new knowledge that can be utilised in consumer products such as “The Reconnecting Nature” substance and “Forest Dust Baby Cream” that includes diverse microbes from forest and agricultural environments, which aid in correcting the development of the immune system. Research results contain peer-reviewed publications and IPR protection. Subject areas range from the effects of land cover classes on commensal microbiota to consequences of biodiversity interventions. Links: <https://www.helsinki.fi/en/researchgroups/nature-based-solutions/projects/adele>; <https://www.luke.fi/en/projektit/adele-2>

Legacy projects developed using UF-NBS principles

Urban green space planning principles of Helsinki 2011-2021 and the case of Central Park, Helsinki. The planning principles for nature areas, valid until further notice, steer the planning, building and maintenance of green areas that are the responsibility of the Public Works Department. The objectives are as follows:

- Create living environments that are comfortable, sustainable and safe, and enhance residents' health and wellbeing;
- Create a recreational environment that is functional and experiential;
- Build a landscape image of the natural environment that is classy and distinctive;
- Ensure that biodiversity has been respected and the values of conservation areas preserved;
- Ensure that wooded greenbelt areas are vital and sustainable and that their presence is also secured in the future;
- Diversify meadows, fields, small waters, shores and islands;
- Guarantee that the areas surrounding traffic arteries are tended by observing both protective and landscape impacts.

The planning principles for nature management concern all natural green areas such as woods, meadows, rocky areas, shores, wetlands, small water areas, swamps, other natural areas, conservation areas and agricultural areas. The plan has been designed interactively through large-scale stakeholder collaboration at the Public Works Department. The interactivity during the planning process means that those interested have the opportunity to obtain information and participate in the planning process. One can assess a project at various stages of the process and express his/her opinion, and comments can be mailed or sent via e-mail. It is possible to participate in meetings and online discussions, and contact the planner directly. Link: <https://www.hel.fi/helsinki/en/housing/nature/maintenance>;
https://www.hel.fi/static/hkr/julkaisut/2011/luonnonhoito_web.pdf

The city of Helsinki has also prepared a publication on ecosystem services in landscape planning. The publication is intended to be used as a support when recognising the values and perspectives of ecosystem services in spatial planning. Link: https://www.hel.fi/static/hkr/julkaisut/2017/esp_julkaisu_20170321.pdf

Nature and landscape planning in Helsinki and the case of Central Park. Helsinki's land use is planned in ways that those interested have the opportunity to obtain information and participate in the planning process. When planning Central Park's nature management master plan, for example, residents are informed about the content in briefings where they can give feedback to the plan. It is also possible to give feedback on the draft online in the "Tell it on Map" service. In addition, stakeholder meetings have been held on drafting of the plan. Feedback will be taken into account in the preparation of the plan.

Central Park is being continuously developed as a forested recreational area that provides city dwellers with daily opportunities for outdoor exercise and enhances their appreciation of the natural environment. Besides outings, people visit the park to play, do fitness training or sports, tend their allotment gardens, study nature, and just relax. Many city dwellers pass through the

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park daily on their way to work. The forests in the park are managed to preserve biodiversity in the face of environmental stress and intensive recreational use. Central Park is managed according to a long-term nature management plan, jointly prepared with the authorities and local residents, as described above, which takes into consideration landscape and environmental values, recreational use, and the desires of the park's users. A new nature management plan is in the making. Links:
https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/muut/keskuspuiston_suunnitelma_2018-2032.pdf;
<https://www.hel.fi/hel2/keskuspuisto/eng/1centralpark>;
https://www.hel.fi/static/hkr/julkaisut/2011/luonnonhoito_web.pdf

The Fifth Dimension – Green Roofs in Urban Areas. The project examined (2011-2014) the components of sustainable green roof solutions suitable for Finnish urban conditions from an interdisciplinary perspective. Green roofs offer opportunities, such as stormwater management, recreation and rehabilitation services, a more aesthetic urban environment and increased urban biodiversity. The project produced research-based, tested and functional as well as cost-effective tools for sustainable urban planning and construction. It promoted business opportunities in the field and involved several companies from the Uusimaa region in southern Finland. Links: <https://www.helsinki.fi/en/researchgroups/fifth-dimension-vegetated-roofs-and-walls-in-urban-areas>

National Urban Parks (NUPs). A National Urban Park is a combination of valuable culture and natural landscapes as well as recreation and protected areas, located in an urban environment. It is defined by the Land Use and Building Act. The city has committed itself to the conservation and maintenance of the NUP. NUPs are part of sustainable urban planning and construction. In an effort to found such a park, the city submits an application to the Ministry of the Environment, which makes the decision about founding a National Urban Park. When identifying and evaluating NUPs, the Ministry of the Environment utilises a set of criteria that ensures that cities are treated fairly and that the high national standard of the NUPs is maintained. These criteria apply to the content, extent, cohesiveness, ecology and continuance of the area proposed as the park as well as its urbanity. The area must be maintained and developed by protecting and reinforcing its recreational and social values as well as its natural and cultural heritage values. To achieve these goals, the city will draft a maintenance and use plan which is approved by the Ministry of the Environment. Finland has ten NUPs at the moment. Link: http://www.e-julkaisu.fi/hameenlinnan_kaupunki/national-urban-parks/mobile.html#pid=1

Viherkehä (Green Ring) and the Green Fingers. The hundreds of protected and recreational areas surrounding Helsinki in a radius of 40 km are called Viherkehä (Green Ring). Several strips, the most central of which is Helsinki Central Park, reach into the Viherkehä from Helsinki and Espoo. The Green Ring combines different natural reserves in an unbroken chain around Helsinki. Links: <https://www.haltia.com/assets/Pdftiedostot/ViherkehaNettiesite/ViherkehNetti.pdf>;
<https://slowfinland.fi/en/helsinki-the-worlds-nature-capital>;
https://www.uudenmaanliitto.fi/files/17028/Helsingin_seudun_viherkeha_E_151_-_2015.pdf;
<https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/esitteet/esite-01-18-en.pdf>

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A long time ago, Helsinki had to expand along the two railway lines to the north-west and to the north-east, leaving the in-between areas and bays fairly unbuilt. This situation created the basis for the finger-like urban and green structure of Helsinki. The green infrastructure (Helsinki General Plan 2002) of Helsinki shows six finger-like parks radiating from the city centre into the surrounding rural areas. The Helsinki Park continues southwards through the estuary of the Vantaajoki river, Old Town Bay (Vanhankaupunginlahti) into the adjacent archipelago, including the chain of military islands extending southeast from the Helsinki Peninsula. The green fingers of Helsinki are a combination of different types of nature. (https://www.hel.fi/hel2/ksv/julkaisut/aos_2016-2.pdf)

3 UF-NBS case studies in China

This section presents urban UF-NBS case studies and projects in China. For the Chinese cities selected for the review, one or more UF-NBS case studies have been reported; single or several cities have also been considered. The scope of this section is not to make a comprehensive list of all the existing case studies in China, but to provide an overview of selected examples of UF-NBS implementations. It is worth noticing that these examples were supplied by the project partners involved in this WP and other WPs for their respective cities. We have analysed all the material received and summarised each example of UF-NBS to highlight the main typology, objectives and intended impacts. Indeed, the selected UF-NBS includes various typologies, such as afforestation, riverbank green, urban wetland park, botanical garden and agricultural park, which made it difficult to create a homogeneous and consistent structure for discussing all the cases. As explained in Section 2, effort was directed towards the organisation of these cases in a meaningful way so they could be used as testbeds for further implementation of UF-NBS. The following case studies are meant to complement the subsequent analysis of the case histories in Sections 4 and 5.

3.1 Beijing

Beijing Plain Area (Afforestation Programme). Launched in 2012 by the government in Beijing, the Beijing Plain Area Afforestation Program (BPAP) is the largest afforestation programme in the capital's history. This Programme proposed green strategies with nine green wedges, multiple greenbelts and green corridors throughout the historic city centre. Several of the UF-NBS actions planned by the BPAP include planting 66,674 ha of new trees by converting vacant lots, croplands, sand excavation pits and wastelands into forests, parks and wetlands. By the end of 2015, BPAP will have increased forest cover from 14.8% (in 2011) to 25% (in 2015) in the plain area. UF-NBS typology includes community parks, historical gardens local areas for play, wooded riverbank green, tree rows, ponds, lakes and hydrographic networks, among others. Given this variety, numerous ecological functions will be carried out by related ecosystem services, such as air and water quality purification, urban heat island mitigation, as well as meeting the needs of the community (recreation, social activities, environmental education). Connectivity of the urban forest system is one of the most important goals in the BPAP.

For the implementation of this UF-NBS programme, various stakeholders were involved in a synergistic participatory process: governing authorities of Beijing and local municipalities; park

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planning and other associations; scholars/professional experts; technicians; public and private institutions; and citizens. Among the lessons that this UF-NBS teaches is the need for a strong administrative capacity to improve the efficiency and effectiveness of projects in a highly urbanized area and citizens' awareness of environmental protection.

Launching of the BPAP was based on the demands of urban residents, with the aim to create a larger and more liveable urban environment for citizens. Multiple level government agencies (e.g., municipal office, district gardening and greening bureaus), non-government (private project contractors, seedling/nursery companies, NGOs/volunteers, universities/research institutes) and individual citizens were the main actors of the programme. Planning, implementation and management were funded by government revenues. Beijing Municipal Government approves the plain afforestation plans. The Capital Greening Office (Beijing Gardening and Greening Bureau) provided the guidelines for the afforestation of the BAPA. The programme was mainly funded by municipal and district government revenues; the total cost amounted to \$5.0 billion USD.

The BPAP is a good example of top-down UF-NBS planning that can be applied to rapidly urbanising cities with limited land for urban green space. This is mostly due to the strong administrative capacity which its efficiency and effectiveness.

3.2 Fuzhou

Hilly Area, Fuzhou (Fuzhou/Fujian province). The Fu Forest Trail ('Fudao' in Chinese) is a mountain forest trail project built by the Fuzhou government in 2016. It is not a traditional ground-based mountain trail, but a new mountainous slow-moving system based on the design concept of a "treetop walkway". Fu Forest Trail has a delicate architectural structure, and the trail platform is suspended over an urban mountain forest. In August 2018, Fu Forest Trail was opened to the public. It is highly accessible so that at least 200,000 people living in the area can benefit directly.

The true purpose of the construction of Fu Forest Trail is to promote policies related to the protection of urban mountains and urban green restoration. Actually, as a mountainous city, Fuzhou is facing a dilemma: in the past decade or two, the urbanisation process has swallowed up many of the green hills in the city. In order to make good use of urban mountains and their associated forest resources, maintain the characteristics of the urban landscape, and give more consideration to protection and development, conflicts need to be managed between high-intensity construction requirements as well as the conservation of the urban landscape and open green space protection.

Ecosystem services provided by the project are: protection of the forest cover and urban green space; health and wellbeing benefits gained through the use of recreation facilities; and the provision of educational facilities for local residents and visitor-related services. Principle UF-NBS actions include forest plantations, recreational public spaces, improvement of urban forest landscape connectivity; and the construction of multiple scale urban parks.

The Fu Forest Trail brings together, in a synergistic participatory process, a variety of actors and their knowledge from different disciplines (e.g. ecology, urban planning, urban forestry,

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forest management, social sciences) including administrative authorities, landscape planners, scholars/professional experts, farmers, citizens and technicians who educate and support citizens/groups in maintenance and initiatives as well as in undertaking monitoring activities. Among the local stakeholders are the Metropolitan City of Fuzhou, NGO, local contractors, citizens, public/private institutions, research institutes, and park authorities.

Lessons learned and transferability: The design of Fu Forest Trail, as an elevated steel structure, adopts many new concepts that are different from the traditional urban forest trails, creating a precedent for the rigid frame suspended plank road in China. It has aroused great interest from the public, made the trail famous abroad, and exerted a huge social impact. Although the treetops allow a wide view and good air permeability, the shading effect is slightly insufficient. It is hoped that Fu Forest Trail can be a model for designing similar projects.

3.3 Meishan

Meishan Dongpo Urban Wetland Park, Meishan City, Sichuan province. Dongpo Island, on the east side of the city of Meishan, is in the process of becoming a new development centre. It is positioned as an important ecological leisure oasis in Meishan's central recreational area and urban core area. It plays a major role in passing down the cultural context of the old city and driving the cultural development and overall development of the new district. With a total area of about 69 m², Dongpo Urban Wetland Park is the largest core green space on Dongpo Island. With a mix of wetland conservation, science and cultural education, rest and recreation, it is a typical urban wetland park. Park construction officially began in 2014, and the park was officially opened to the public on 31 December, 2014. The spatial planning of the park is divided into one axis (water moon central cultural axis in Dongpo), two belts (walking belt along the Bin Lake and water moon science and culture ecological belt), and five zones (wetland resting zone, wetland science and culture zone, recreational activity zone, ceremony activity zone and cultural activity zone). The main challenge consisted in promoting the smooth development of Dongpo Island by connecting the east and west sides of the Minjiang River, guiding the city to develop eastward, and fulfilling its utmost value in the cross-river development of Meishan.

The typology of UF-NBS is characterised by trees in public parks, riparian and natural wetlands as well as a woodland play area. The UF-NBS foreseen for the project include reserving the native wetland forests during urbanisation, upgrading of the water quality, enhancing the wellbeing of citizens, and increasing biodiversity in the urban landscape. Stakeholders for the project include: governing authorities (i.e., Meishan and Dongpo District Government, and Municipality of Meishan), NGOs, citizens (as volunteers), the University of Tongji, and technicians for park maintenance that also educate and support citizens. Meishan Dongpo Urban Wetland Park met with great success. It not only retains the original environment and living space of the original wetland's organisms, but also creates a new green leisure space for urban residents. At the same time, it uses the ecological function of the wetland to realise the restoration of urban water quality. This park provides green space for the community, increasing the value of real estate.

The Meishan City Bureau of natural resources developed a master plan for this urban wetlands project and opened tendering for the society to implement the master plan. The project was

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funded by the state-owned company (Meishan Development Holding Co., Ltd); total investment was about 800 million RMB.

3.4 Jiaxing

The **Green Wedges** project (2006-2020) planned for the city of Jiaxing, in **Zhejiang province**, consists in the construction of three green wedges around the city based on existing ecological resources: the south green wedge, east green wedge, and northwest green wedge. The three green wedges are mainly constituted of wetland and forests and have a tight connection with the inner city through rivers. The south green wedge covers 4.72 km² and is composed of three parks: a sports park, children's park and botanical garden. The northwest green wedge is 3.54 km² in surface area and functions as a wetland park. The east green wedge covers an area of 6.92 km² and has gradually been changed into city parks.

The UF-NBS typology consists of tree rows, single trees, tree and forest plantations, trees in public parks, along streets and in squares and cemeteries. Principle UF-NBS actions include wetland restoration, the annual implementation of new plants and trees, and urban park construction. These wedges are important components of the Jiaxing urban green space system and are aimed at regulating the urban climate (reduction of the urban heat island effect) and providing more recreational space.

The three green wedges were planned and implemented by the local government. Professionals, experts engaged in urban planning, landscape ecology, economy, forestry, transportation, and wetlands were involved as well. At the same time, citizens were able to actively contribute to the planning in an extensive participation and coordination process. The project shows that trees as UF-NBS are a way to promote co-development and co-design to alleviate the problems of heat, air pollution and noise in the city in a participatory way.

The green wedges strategy is led and financed by the municipal government, with the aim of enhancing the structure and socioecological multifunctionality of the green infrastructure in the city. It was developed under the master plan of Jiaxing city. One of the governance challenges is how to manage and conserve the current three green wedges, which is in strong conflict with urban expansion. Nevertheless, the green wedge system brings more green jobs for local people aside from offering ecosystem services (e.g., regulation of the micro-, local and/or regional climate).

3.5 Yiwu

Green Lungs of the City Project, Yiwu (Zhejiang Province). To create more green spaces for residents in Yiwu, mitigate environmental pressures, and improve city resilience, the municipal government launched the Green Lungs of the City Project (GLCP) in 2019. The overarching goal was to build a green lung. The aims of the GLCP are to build a large botanical garden for the city, create a forest-wetlands park, and develop an agricultural park for citizens. In addition, the trees were planted to reconnect roads, rivers, ponds and lakes by creating ecological corridors. The GLCP is a typical ongoing project which uses urban forests and trees as well as wetlands as UF-NBS to promote sustainable urban development and to provide multiple ecosystem services in a highly urbanised area.

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The GLCP covers an area of 8.4 km². UF-NBS typology includes: woodland play areas (e.g., urban forest parks); tree rows; wooded riverbanks, ponds and lakes, natural and semi-natural water bodies and hydrographic networks (i.e., river corridor, lake banks, pond); ornamental trees; a botanical garden; and bioswales with trees and constructed wetlands. A selection of plant and tree species (i.e., native tree, non-indigenous ornamental tree) could prevent plant source pollution, i.e. from willow and pollen. The UF-NBS actions employed are: reforestation and afforestation, including forest plantations; restoration of wastelands and wetlands and ponds; improvement of urban forest and wetland connectivity by creating ecological corridors; preservation of plants around reservoirs to improve water quality; removal of dilapidated buildings; protection of native tree species; and the creation of a greenway for bicycling.

The GLCP was funded by a state-owned company and was planned and implemented at the municipal (with the master plan of Yiwu City) and sub-district levels by means of public-private participation (PPP). Similar to other Chinese UF-NBS examples, a variety of stakeholders participated in its realisation; these include governing and park planning authorities; various associations (e.g., Yiwu Bureau of Culture and Tourism); citizens, such as park wardens and associated members; municipalities of the sub-districts (Futian, Houzhai); public institutions; and technicians for park maintenance/monitoring and to educate and support citizens. The project offers a number of ecosystem services, such as the enhancement of biodiversity in urban areas, water purification, recreational space for citizens, which can benefit human health and wellbeing, and employment opportunities (e.g. workers/staff to manage the new afforestation sites, develop eco-tourism). Because it is an ongoing project, the GLCP represents a good field lab for UF-NBS, especially for modelling implementation and management.

3.6 Qingdao

Fushan Ecological Park, Qingdao (Shandong Province). Qingdao is located on China's Yellow Sea coast. It is a major city in the eastern Shandong Province with a metropolitan area covering 10,654 km². Given the rapid urbanization and tourism impacts on the city's environment and human settlements, the degradation of the coastline and habitats of flora and fauna caused by real estate expansion and sea farming, urban parks were unable to provide enough space for citizens and adequate connectivity of the urban greenscape. To restore the Fushan mountain environment, the government of Laoshan district launched the "Ecological Park" project in 2016. Its goals were to restore the Fushan mountains using NBS, improve landscape connectivity and provide recreational space for citizens.

The project entailed the following UF-NBS typology: forest plantation; woodland play area (e.g. urban forest parks); tree rows; coastal green corridors and belt park; rainwater gardens; ornamental trees; and plants (i.e., native tree species, non-indigenous ornamental tree and plant species). The principal UF-NBS actions planned included the restoration of a quarry and wastelands, removal of illegal buildings and reforestation of the area, afforestation, improvement of landscape connectivity by reconnecting the ecological corridors, preservation of native tree species, and improvement of water storage and flood management. Other related ecosystem services were biodiversity conservation and the health and wellbeing benefits gained through the use of the recreational facilities.

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Aside from the district's government, the Fushan Ecological Park project involved the collaboration of private contractors, seedling/nursery companies, NGOs/volunteers, universities/research institutes or groups. Although citizens were also involved in the planning and implementation of the project, more participation was needed. The park was also a transdisciplinary effort, engaging experts in landscape architecture, ecology, urban planning, water management, biodiversity, and arboriculture.

Two lessons were drawn from this project. The first is that strong administrative capacity improves the efficiency and effectiveness of projects in highly urbanized areas, despite multiple challenges, and secondly that UF-NBS projects contribute to enhance citizens' awareness of environmental protection.

4 Comparative analysis of UF-NBS case histories in Europe and China

The purpose of this section, within the frame of Task 1.2, is to provide a structured interpretation of the current knowledge in UF-NBS research and practice and to collate evidence on insights into common or contrasting aspects in and between the two continental regions, Europe and China. To facilitate this, examples of current practice, which are generally at the 'project level' were collected by researchers in Europe and China in collaboration with 'key informants' for each. To distinguish these from the comparative case studies (city scale) being undertaken in WP 2 of CLEARING HOUSE and also in recognition that the examples are existing projects, a decision was taken to call them 'case histories'. Therefore, a template was built for each case history in collaboration with Task 1.4 primarily to ensure that key informants would only be asked once for data.

To allow for cross-case comparisons and comparative analyses, a total of 22 case histories were collected from project partners and reviewed between June 2020 and January 2021: 16 from Europe and 6 from China (see: OPPLA.eu and/or the NetworkNature/OPPLA platform). Each case history was investigated for the main UF-NBS intended outcomes and unintended impacts of UF-NBS, as well as the methodologies used in UF-NBS research and implementation, NBS typology and functions (i.e., ecosystem services), the lessons learned and transferability of such UF-NBS examples as well as their potential for Sino-European relevance.

4.1 Methodology used for the comparative analysis

In the first comparative analysis, i.e. Section 4, a cross-case comparison was conducted of the data provided by the categories in the 22 case history templates for Europe and China, based on previous work by HUB partners. (For the second comparative analysis and relevant methodology, see Section 5.) These data were extracted and complemented with additional categories of UF-NBS practices (e.g., Renaturing) also taken from the templates and collated into a master table (Table 2). The final categories of UF-NBS practices selected for the cross-case comparison are based on their relation to the scope of this deliverable, i.e., to investigate UF-NBS impacts on urban liveability, public health, biodiversity loss and urban resilience and to collate evidence on intended outcomes and unintended impacts of UF-NBS for urban ecosystem regeneration and human wellbeing. Therefore, the following specific categories were chosen: UF-NBS typology, principal UF-NBS actions, non-UF-NBS actions, ecosystem

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services, network/connectivity, integration, multifunctionality, inter- and transdisciplinary, renaturing, social cohesion and biocultural diversity, Sino/European comparative relevance, UF-NBS valorisation, renaturing, and lessons and transferability. Subsequently, a colour-coded scheme was used to highlight the themes found in each category across all the case histories (Table 3). For example, for the category ‘Non-UF-NBS actions’, parking lots or information signs for tourists were coded in grey as they represented the theme *grey infrastructure*, while yellow was used to code the theme *citizen engagement* for the case history Park forest Grmoščica, Zagreb, Croatia. The colour-coded scheme allowed to identify those themes that were more or less in common and divergent among the European and Chinese case histories themselves and between both continents, enabling thus to draw conclusions on similarities and differences within and across each continent. The comparative discussions of the European and Chinese case histories are presented below in sections 4.2 and 4.3, respectively.

Table 2. European (blue) and Chinese (pink) case histories reviewed and compared for UF-NBS practices.

Name	UF-NBS typology	Principle UF-NBS actions	non-UF-NBS actions	Integration	Network/Connectivity
Aarhus City, Denmark	LCC/LUC classes (see map above): Continuous urban fabric; Discontinuous dense urban fabric; Discontinuous medium dense urban fabric; Open spaces with sparse or no vegetation; Discontinuous very low dense urban fabric; Little vegetation; Green urban	•Street trees increase number of street trees •Carbon sequestration •Plan to double the nature area in the municipality – increase the recreational area within the city. On a voluntary basis. •Make near-urban forest with biodiversity	•Flood mitigation and green roof •Urban heat regulation from vegetation •Enhance urban biodiversity •Citizen and school project involving, educating and awareness raising on biodiversity and ES, pro •Establishment of climate school involving	(Not sure how relevant this is since we having a whole city perspective? Integrated LCC/LUC classifications that is used above?) E.g., Continuous urban fabric; Discontinuous dense urban fabric; Discontinuous medium dense urban fabric; Open spaces with sparse or no vegetation;	Connectivity is part of the strategy when increasing nature in the municipality. Instruments for looking at network and connectivity are: Blue/green structure, nature quality of protected areas, Green Norm,
Bois de Vincennes, Paris, France	Forested areas; Green urban areas, pocket parks; Historical gardens; Large urban public park; Amenity green spaces; Locally equipped areas for play; Hedgerows; Urban gardens with trees	•Creation of conditions for the spread of certain species (dry rocks, dead branches, ponds, water streams, etc.) • Natural zone of ecological interest, fauna and flora (ZNIEFF) •Bird reserve, “witness” plots; • “green buffer” connecting the eastern suburbs of Paris;	•Encourage engagement of citizens with local green initiatives (educational programmes, shared gardens); •Provide a foundation for spiritual, scientific, educational, recreational, and visitor opportunities, all of which must be environmentally compatible with circular economy activities;	Built-up structure; Transport infrastructure in the vicinity (from the rest of the metropolis, metro, regional train, bus, tramway).	The park is entirely within the boundaries of the city of Paris; seven municipalities border the park. The park can be accessed by different means of transportation: personal vehicle, metro, train, shared bicycle, tramway.
Hilly area (Fu Forest Trail), Fuzhou, China	•Forest Trail •Community parks, green urban areas, historical gardens or country parks with trees (i.e., large urban public park, amenity green spaces, local areas for play [LUP]); •Woodland play area (e.g. urban forest parks);	•Provision of new infrastructure/facilities: •Forest plantations •Provide a variety of recreational spaces for the public •Improvement of urban forest landscape connectivities •Construction of multiple scale urban parks	•Recycling of construction waste/garbage (e.g. using concrete from removed buildings in landscape architecture such as park paths, garden ornaments) •Recreational and environmental educational activities (e.g., workshops for urban birds, bees or butterfly biodiversity)	Built-up structure (e.g., environmental education bases); Transport infrastructure (e.g., parking lots)	NA
Meishan Dongpo Urban Wetland Park, Meishan, China	green urban areas Woodland play area (e.g. urban wetland-forest parks); Trees in public parks Riparian, natural wetlands	Preserving the native wetland forests during urbanization Water environment has been improved through the upgrade of water quality in urban wetland forest Enhanced well-being of urban citizens	•Provides sites for environmental education, such as accessible sunken wetlands, which can be used to observe habitats in underwater wetland.	Built-up structure (service facilities); Transport infrastructure (mostly along streets and in squares); Water management system (e.g., regulation and restoration of wetland water quality).	The difficulty of wetland park design is how to promote the smooth development of Dongpo Island, connect the east and west sides of Minjiang River, guide the city to develop eastward, and fulfill

Table 3. A colour-coded scheme highlights the different themes found for the specific category ‘non-UF-NBS actions’ across the analysed 22 UF-NBS case histories. The themes are colour-coded as follows: citizen engagement (yellow); grey infrastructure (grey); cultural activities (e.g., environmental education, recreation, leisure) (purple); healthcare (red); and non-green/blue interventions or processes that support UF-NBS to deliver ecosystem services (green/blue).

European case histories	Non-UF-NBS actions
Donau-Auen National Park, Vienna, Austria	<ul style="list-style-type: none"> • Citizen engagement with local green/green initiatives • Spiritual, scientific, educational, recreational, and visitor opportunities - all must be environmentally and culturally compatible
Stadsrandbos Oostende peri-urban forest, Belgium	<ul style="list-style-type: none"> • Vegetable garden • Children’s farm
Parkbos Ghent, Belgium	<ul style="list-style-type: none"> • Restoring brook systems



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Renforcement du Réseau Écologique Bruxellois, Brussels, Belgium	<ul style="list-style-type: none"> • Participatory urban planning of public space and private gardens • Bathing areas • Re-think public lighting to enhance biodiversity
International Horticultural Exhibition 2024, Łódź, Poland	<ul style="list-style-type: none"> • Big outdoor events e.g., exhibitions, fairs, concerts; • New park infrastructure, leisure equipment, pavilions and restaurants at exhibition site.
Landschaftspark Duisburg-Nord, Germany	<ul style="list-style-type: none"> • Culture <ul style="list-style-type: none"> - Festivals & concerts - Lights (evenings) • Leisure <ul style="list-style-type: none"> - Climbing walls and high ropes of old buildings - Indoor diving tank – filled from canal - Bike rental; cycle path – connects surroundings, encourages cycling - Footpaths - Skate and BMX parks - Playgrounds - Pet corner - Geocaching • History <ul style="list-style-type: none"> - Tours through iron works; themed topics e.g. steel furnaces, Torch Tours - Viewing platform
Water Haigh Woodland Park, Leeds, UK	<ul style="list-style-type: none"> • Over 14.5 km of Public Rights of Way, plus an extensive network of permissive paths which allow walkers, cyclists and horse riders to explore the whole valley. • Setting up of the Friends of Water Haigh Woodland Park, who organise numerous activities and events for local communities, and are involved in management decisions.
Park forest Grmoščica, Zagreb, Croatia	<ul style="list-style-type: none"> • Participatory approach by engaging local key stakeholders in workshops, public discussions and visitors' survey • Educational activities (forest pedagogy) in “green classroom” (the existing green classroom facility will be extended) • Signs on how to arrive and information sharing with tourist board • New parking lots at entrances
Serra de Collserola Natural Park, Barcelona, Spain	<ul style="list-style-type: none"> • Preservation of agricultural belts at the peri-urban fringe • Introduction of traditional practices to maintain habitats, decrease fire risk and promote landscape diversity (i.e., grazing) • sustainable food cultivated in the park • Preservation and improvement of ecological connectors (i.e., small rivers, like Riera de Sant Cugat, Riera de Vallvidrera, or Torrent de Can Cabassa) • Regulation of bicycle path networks and bike numbers • Dynamic naturalist and NGO actions to promote and disseminate park's values and environmental education (e.g., bird watching, drawing and photo workshops, gamification, guided itineraries)
Tivoli, Rožnik and Šiška Hill Landscape Park, Ljubljana, Slovenia	<ul style="list-style-type: none"> • City park
Old Town Bay (Vanhankaupunginlahti), Helsinki, Finland	<ul style="list-style-type: none"> • Recreation and well-being benefits for residents and tourists, environmental education activities • Create a new common web portal, https://citynature.eu/en/ and mobile application for nature-based tourism and education in Helsinki



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“Baumstarke Stadt”, Leipzig, Germany	<ul style="list-style-type: none"> • Citizen engagement with local green and green initiatives
Parco Nord Milano, Milan, Italy	<ul style="list-style-type: none"> • Soft mobility plan introduced a bike path network to encourage bike riding/sharing to impact climate change adaptation and connectivity • Recreational and environmental educational activities (e.g., bowls on park grounds; workshops and organised tours of the park)
L. Braille Public Garden, Bari, Italy	<ul style="list-style-type: none"> • Four access gates in line with garden’s paths to provide continuity • Various networks: black sewer, water, electricity supply, public lighting system, irrigation, video surveillance (to be installed) • Computerized drip irrigation system for vegetation; lawn is irrigated by dynamic pop-up sprinklers • Fence protects the garden from nighttime vandalism and for security • Soft mobility plan with a central footpath and bi-directional foot-/cyclepaths leading to outside parking spaces; spaces inside equipped for children to encourage bike riding, all impacting climate change adaptation • Restroom facilities, also for the disabled • Recreational areas (e.g., game tables, playground)
Aarhus City, Denmark	<ul style="list-style-type: none"> • Flood mitigation and green roof • Urban heat regulation from vegetation • Enhance urban biodiversity • Citizen and school project educating and raising awareness on biodiversity and ESS • Establishment of climate school involving test of NBS solutions
Bois de Vincennes, Paris, France	<ul style="list-style-type: none"> • Citizen engagement with local green initiatives (educational programmes, shared gardens) • Spiritual, scientific, educational, recreational, and visitor opportunities - all must be environmentally compatible with circular economy principles
Chinese case histories	Non-UF-NBS actions
Hilly area (Fu Forest Trail), Fuzhou, China	<ul style="list-style-type: none"> • Recycling of construction waste/garbage (e.g., using concrete from removed buildings in landscape architecture such as park paths, garden ornaments) • Recreational and environmental education activities (e.g., workshops on urban birds, bees or butterfly biodiversity)
Meishan Dongpo Urban Wetland Park, Meishan, China	<ul style="list-style-type: none"> • Sites for environmental education (e.g., accessible sunken wetlands, which can be used to observe habitats in underwater wetland).
“Green Wedges”, Jiaxing, China	<ul style="list-style-type: none"> • Citizen engagement in voluntary tree planting
Green Lungs of the City Project, Yiwu, China	<ul style="list-style-type: none"> • Build new public infrastructures (e.g., roads) • Recreational and environmental education activities (e.g., workshops on urban birds, bees or butterfly biodiversity, and native tree species, based on the botanic garden and wetlands park) • Develop cultural tourism industry (e.g. playground for agricultural activities, catering services), eco-agricultural industrialization, health industry (e.g. green care)
Plain Area (Afforestation Programme), Beijing, China	<ul style="list-style-type: none"> • Recycling of construction waste/garbage (e.g. using concrete from removed buildings in landscape architecture such as park paths, garden ornaments) • Recreational and environmental education activities (e.g., workshops on urban birds, bees or butterfly biodiversity) • Field site for urban field station

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<p>Fushan Ecological Park, Qingdao, China</p>	<ul style="list-style-type: none"> • Build new public infrastructures (e.g., roads, parking lot) • Recreational and environmental education activities (e.g., workshops on urban birds, bees or butterfly biodiversity, and native tree species, based on the botanic garden and wetlands park), build playground for citizens • Improve the cemetery landscape • Recover the coastline and beach
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4.2 European case histories

The 16 European countries whose UF-NBS case histories have been reviewed are the following: Vienna, Austria (Donau-Auen National Park); Belgium (Parkbos Ghent, Stadsrandbos Oostende peri-urban forest, and Renforcement du Réseau Écologique Bruxellois, Brussels); Łódź, Poland (International Horticultural Exhibition 2024); Germany (“Baumstarke Stadt”, Leipzig, and Landschaftspark Duisburg-Nord); the United Kingdom (Water Haigh Woodland Park, Leeds); Zagreb, Croatia (Park forest Grmoščica); Barcelona, Spain (Serra de Collserola Natural Park); Ljubljana, Slovenia (Tivoli, Roznik and Šiška hill Landscape Park); Helsinki, Finland (Old Town Bay - Vanhankaupunginlahti); Italy (Parco Nord Milano, Milan, and L. Braille Public Garden, Bari); Denmark (Aarhus City); and Paris, France (Bois de Vincennes). The case histories are based on partner contributions and are not representative of their countries. In the sections hereafter, we refer only to the case history being considered for the countries listed above. It is beyond our goal to generalise the knowledge gathered through the case histories at country level. In addition, for convenience whenever a country is mentioned the respective case history is intended and not the entire country. The typology (including ecosystem services and multifunctionality), intended outcomes (principle UF-NBS actions), unintended impacts, lessons to be learned and Sino-European relevance are reported below.

UF-NBS Themes

Typology

The 16 European case histories reviewed have a number of UF-NBS typologies in common. These mostly concern small to large (even national) urban parks (e.g., in France, Slovenia, the UK, Austria and Belgium as well as most other countries), community gardens, flowerbeds, shrubs, hedgerows, trees and tree rows, wooded areas, and green/wooded playgrounds (in Spain, Poland, Italy, Denmark and Belgium). Larger urban forested areas were mainly found in case histories in Austria, Belgium, Denmark, Croatia, Spain, Finland, and France, while riparian forests are identified in Finnish and Austrian case histories. Species-rich meadows were found in Finland, Italy, and Slovenia. Singular cases of UF-NBS typologies are exemplified by wooded railway banks and green roofs in a German case history, vineyards and dry cereal fields in the Spanish case history, and permeable pavement in Belgium (Brussels case history). Urban grassland is a characteristic UF-NBS of case histories in Austria, Germany and the UK. Structures designated for food and resource production (e.g., foraging) are found in Slovenia and Italy. Small parks and gardens such as pocket parks and house gardens and small farms, and green elements such as neighbourhood green, street trees, shrubs, ornamental plants and green playgrounds are common to all 16 case histories.

Waterbodies are also a common type of UF-NBS in the European case histories examined, although not as many have implemented them. Some examples are hydrographic networks (e.g.,

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river corridor), as in Finland and Germany, and wetlands (riparian forests/riverbank green/rivers and creeks/ponds) as in Austria, Germany, Slovenia and the UK as well as constructed wetland, lake, reservoir, and estuary in Denmark. A few case histories have in common canal systems and water retention basins, as can be found in Denmark and two case histories in Italy.

The functions performed by the different types of UF-NBS are identified by the ‘ecosystem services’ they offer. For example, all green elements and, in particular, small to large urban parks, forests and meadows help to regulate the microclimate, provide habitats for animal and plant species, offer recreational and educational value, ecological connectivity and improve human health and wellbeing, as in the case histories of Barcelona, Spain and Paris, France. The larger UF-NBS, such as forests and meadows, provide food and resources as well. Considering Slovenia and Italy as examples, in both countries agricultural fields provide foraging for wild berries and fruits, while in Slovenia they also provide timber. In the Austrian and Germany case histories, such UF-NBS provide water for drinking and non-drinking purposes, respectively. Urban parks and relative green elements provide all categories of ecosystem services (i.e., provisioning – such as food; regulating – air purification; supporting – restoring biodiversity; and cultural – aesthetic appreciation). With regards to waterbodies, canal systems, riverbank green, and water retention basins, whether natural or semi-natural, prevent communities from floods (in the case histories of the UK, Belgium, Austria, Denmark and Italy), and the forested wetlands of Helsinki, Finland secure important biodiversity besides recreational/educational activities and wellbeing benefits.

Overall, in the majority of the 16 case histories the multifunctional properties of UF-NBS maximise the ecosystem services offered in the sites and local communities. This is dependent, however, on their small, medium, or large dimension and specific scale (urban or peri-urban location) and, in this case, such ecosystem services may differ. An interesting singular example, however, is the UF-NBS in the city of Łódź, Poland, which in contrast with other UF-NBS is a built-up temporary infrastructure, namely the International Horticultural Exhibition 2024. This Exhibition primarily aims at offering cultural ecosystem services, such as aesthetic appreciation, cultural heritage, social cohesion, leisure and educational value, although other fewer ecosystem services are still provided (e.g., air purification). Tourism, sightseeing and entertainment represent multifunctional qualities deriving from the cultural ecosystem services provided.

Moreover, the similarities or differences in UF-NBS typology, ecosystem services and multiple functions among the European case histories will likely be influenced by their varying biogeographic regions, climate and landscape characteristics. The regions span from Boreal (Finland), Atlantic (the UK), European Atlantic mixed forests (Belgium) to Continental (Croatia, Germany, Austria), Continental/Alpine (Slovenia), Continental Mediterranean (Italy) and Continental temperate (Poland), and Mediterranean (Spain).

Intended outcomes

The intended outcomes of implementing UF-NBS can also be interpreted in light of “UF-NBS actions”. The latter are expressed as UF-NBS “valorisation” and “renaturing” aspects. In their quest to develop UF-NBS in response to various needs and environmental challenges at urban

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level, the European case histories have aimed to reach one or more intended outcomes. Certain intended outcomes are more commonly shared among some European case histories than others. The most targeted outcomes regard citizens' awareness of nature values, environmental awareness in general, their educational needs and participation in UF-NBS design and planning. These values in relation to UF-NBS development were specifically found for the following countries: Belgium (particularly the case histories Parkbos Ghent, and Renforcement du Réseau Écologique Bruxellois, Brussels), Germany ("Baumstarke Stadt", Leipzig), Croatia (Park forest Grmoščica, Zagreb), Finland (Old Town Bay - Vanhankaupunginlahti, Helsinki), France (Bois de Vincennes, Paris), Spain (Serra de Collserola Natural Park, Barcelona), and Italy (both Parco Nord Milano, Milan, and L. Braille Public Garden, Bari). Other common intended outcomes related to citizens' health and wellbeing and to improving quality of life by enhancing biodiversity and thus providing a variety of ecosystem services, such as regulation of urban climate, recreational and educational facilities, and greater aesthetic appeal. The case histories lending more importance to these intended outcomes are in Belgium, Germany, Croatia, Slovenia, Finland, France, Italy, and Denmark. Other European cities are principally committed to restoring and transforming the urban landscape, expressing these intended outcomes in habitat restoration for plant and animal species (in Spain, Austria, the UK, France, Italy), afforestation of former agricultural land and redevelopment of brook valleys (in Belgium and Denmark), including restoration of lakes/waterbodies to manage water flows and improve water quality (Austria and Denmark), transformation/reclamation of industrial land (the UK, Germany, and Italy) or derelict land (Italy), restoration of coastal meadow (Finland), renaturing of impermeable land and water bodies and mitigating the presence of humans and automobiles (France), increase of aesthetic appeal (Belgium, Germany, and Italy), and climate change and air pollution (Finland, the UK). Different and interesting intended outcomes were found for Finland – (i) creating value from knowledge by making knowledge suitable and/or available for societal use and translating that knowledge into competitive products, services, and processes, and (ii) bringing nature 'digitally' to people through a web portal. An outlier case regards Poland. Covering three separate parks is the Horticultural Expo 2024 in Łódź. The main intended outcome is to shape the urban landscape using green spaces. However, it is currently not being sought, as the exhibition at this stage is being planned to generate attractiveness to the entire region and give prestige to local authorities. Emphasis is on the construction of floral pavilions and pavements, changing the character of the three parks significantly and losing some of their previous functions. Hence, the opposite of renaturing is in process.

Non-UF-NBS actions

In addition to the UF-NBS actions, or intended outcomes, that were highlighted in the 16 European case histories, worth considering are also the UF-NBS actions which are not strictly green interventions, but indirectly related, whether they be infrastructure-like (e.g., recycling of construction waste) or expressed as ecosystem services; the so-called "non-UF-NBS" actions. For the purposes of this report the non-UF-NBS actions are those provided by non-green interventions or processes that support UF-NBS to deliver ecosystem services. Two examples are the mobile app in the Finnish case history of Old Town Bay, which is a non-UF-NBS action that helps visitors to access the forest and become acquainted with its species, and the cultivation of sustainable food in Tivoli, Rožnik and Šiška hill Landscape Park, Ljubljana, Slovenia.

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Comparing the European case histories for implemented non-UF-NBS actions, the most frequently adopted are those regarding cultural, leisure, spiritual, educational, recreational and tourist ecosystem services. These were all found for the case histories of Austria (i.e., Donau-Auen National Park); Barcelona, Spain (Serra de Collserola Natural Park); Germany (Landschaftspark, Duisburg-Nord); Paris, France (Bois de Vincennes); Milan, Italy (Parco Nord Milano); L. Braille Public Garden (Bari, Italy); and Helsinki, Finland (Old Town Bay - Vanhankaupunginlahti). Both Austria and France further included scientific actions, with Finland adding a web portal and mobile application for nature-based tourism and education in Helsinki. Some specific examples of non-UF-NBS actions in this (cultural) category are exhibitions, fairs, and concerts (Łódź, Poland), skate parks and guided tours (Duisburg-Nord, Germany), a “green classroom” (i.e., forest pedagogy) in Zagreb, Croatia, bird watching (Barcelona, Spain), and soft mobility plans (in Milan and Bari, Italy). The second most common non-UF-NBS action found was citizen engagement in local green initiatives, as in France, Austria and Germany. Citizens as well were engaged in the urban planning of public space and private gardens in Brussels, Belgium (Renforcement du Réseau Écologique Bruxellois project). Local key stakeholders were involved in workshops, public discussions and visitors’ surveys, in Croatia. In the Water Haigh Woodland Park project in Leeds, UK, an association of local citizens was formed to organise activities and events for the local communities, and became involved in management decisions. When speaking of non-UF-NBS actions the most frequent thought that comes to mind is grey infrastructure. This was indeed the case, especially for the International Horticultural Exhibition 2024 in Łódź, Poland, where new park infrastructure, leisure equipment, pavilions and restaurants were installed. Another case history featuring several grey infrastructure implementations is Bari, Italy. The urban garden was equipped with various networks (e.g., electricity, computerized drip irrigation, public lighting, restroom facilities, stone furniture, fence against vandalism, parking lot). In a similar vein, re-thinking public lighting to enhance biodiversity was undertaken in Brussels, Belgium. New parking lots at entrances were similarly implemented in Zagreb, Croatia as well as directional signs on how to arrive at Park forest Grmošćica and information sharing with the tourist board. On the other hand, the non-UF-NBS actions found to be most related to NBS interventions in a “green” sense were most notable for Barcelona, Spain, and are the following: preservation of agricultural belts at the peri-urban fringe; preservation and improvement of ecological connectors (i.e., small rivers, as Riera de Sant Cugat and Riera de Vallvidrera); introduction of traditional practices to maintain habitats, decreasing fire risk and promoting landscape diversity through grazing; and sustainable food cultivated in the park (all representing supporting and provisioning ecosystem services). Second in line for the number of non-UF-NBS actions is Aarhus City, Denmark, characterised by flood mitigation and green roofs, urban heat regulation from vegetation, and enhancement of urban biodiversity (i.e., regulating, provisioning and supporting ecosystem services). In Leeds, UK, an extensive network of permissive paths allow walkers, cyclists and horse riders to explore the valley. Lastly, a vegetable garden and children’s farm (provisioning ecosystem services) were implemented in the peri-urban forest of Oostende, Belgium.

Unintended impacts

The unintended impacts of UF-NBS may occur and become inevitable, as certain reviewed European case histories have shown. Such impacts are the unwanted or unforeseen setbacks that arise when a win-win situation (or ecosystem service synergy) is not achieved, particularly

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in the provision of ecosystem services of UF-NBS and by the need to fulfil a demand at the expense of a consequence of that demand. Very often they are determined by lack of financial opportunities for implementing UF-NBS. Strategically planning UF-NBS can limit trade-offs and eventually create synergies instead. Both situations are exemplified in the case history of Donau-Auen National Park (Vienna, Austria), where extending the national park depends on financial means, and the strategic planning process involves park management fulfilling both the demands of daily recreational use and the need to protect the floodplains' forested landscape. Another example regarding UF-NBS strategic planning is the Parkbos forestry project in Ghent, Belgium, which presented an unintended impact. The UF-NBS was designed to increase the forest area for recreational use, but turned into an integrated landscape restructuring project. The approach was rather a consultation where specific groups felt left out of the participation process, resulting in conflicts with local authorities and farmers. Years later, most actors were satisfied with the strategy results and saw the advantages of the project.

Large cities and metropolises must inevitably deal with the issue of densification resulting from the frequent process of rapid urbanisation. Densification can be the cause of other closely related environmental and social challenges. Among the three European case histories reflecting the unintended impacts of densification are Serra de Collserola Natural Park in Barcelona, Spain, Bois de Vincennes in Paris, France, and Aarhus City in Denmark. In the first case, existing pressures became consequent to the complex and rapid landscape changes and population demand in the area, also increasing the risk of fires. These, however, were offset by the introduction of traditional practices to maintain certain habitats in the nature park. In the Bois de Vincennes in Paris, restrictions were imposed on visitor access, use of artificial lighting and motorised transport to tackle densification, air pollution, and the urban heat island as well as to preserve the urban forest. The trade-off is apparent: densification, air pollution and the urban heat island become the priority concerns at the expense of access to visitors and motorised transport. In Aarhus City, Denmark, densification through population growth adds to soil sealing, places additional pressures on existing urban and peri-urban green spaces, increases demand for recreational green space and adds to the challenge of finding space for UF-NBS to manage pluvial flooding. Other challenges of Aarhus City are water flow management and water quality, air pollution, rising sea levels, cloudbursts leading to pluvial flooding events causing discontinuous urban fabric as well as economic and social costs. Pressures from intensive land use practices and urban land cover pose a substantial challenge to meet biodiversity goals.

Three of the 16 European case history descriptions did not include unintended impacts, or trade-offs. These are Old Town Bay (Vanhankaupunginlahti), Helsinki (Finland), Parco Nord Milano, Milan (Italy), and L. Braille Public Garden, Bari (Italy). This review does not rule out the possibility that the other case histories analysed do not generate unintended impacts from their implementation of UF-NBS among those that did not provide information regarding strategic planning, valorisation, renaturing and lessons learned (e.g., Tivoli, Rožnik and Šiška hill Landscape Park, Ljubljana, Slovenia). Nevertheless, the case histories that were compared for unintended impacts of UF-NBS show how important and challenging it is to balance different dimensions of UF-NBS, such as the social, economic, ecological, and engineering dimensions.

Lessons learned and transferability

The European case histories examined provide insightful information regarding the lessons that can be learned and the transferability of each UF-NBS presented. Among the most common lessons from which users and target groups can extract valuable information is the value of preserving UF-NBS to offer a wide range of benefits through ecosystem services (e.g., Oostende, Belgium is able to expand tourism with new UF-NBS). The management strategy of a park forest in Paris, France focusses on enriching and protecting its biodiversity and limiting the visitor footprint and access to motorized vehicles. In Duisburg-Nord, Germany, combining UF-NBS with historic elements (e.g., trainline, blast furnaces) are a way to contribute to the preservation of biodiversity and keeping sense of place as well as providing space for recreation and events, sports and leisure. This initiative is also a successful example of structural change from heavy industry to a large open green space. From this perspective, other valuable examples of renaturing post-industrial and derelict sites are two cases in a large peri-urban park in Milan and a small urban public park in Bari, Italy.

Sound strategic planning has shown to be key in successful UF-NBS implementation. Such planning results depend on an interplay of numerous and relevant elements inclusive of planning tools such as fundraising campaigns (Leipzig, Germany), specific mapping tools to examine the contribution of afforestation on health and wellbeing (reduce air and noise pollution and stress, increase social cohesion), as in the case of the Regreen project in Aarhus City, Denmark. Moreover, streamlined political, scientific and planning instruments are necessary for setting norms and guidelines in connection with a knowledge base of sorts, as in Barcelona (Spain), Duisburg-Nord (Germany), and Milan (Italy), that stems from the cooperation among different sectors of expertise, networks of institutions and exchanges with public authorities.

The majority of the case histories investigated have widely adopted the participation of multi-scale stakeholders in a synergistic process, starting from engagement with citizens in UF-NBS planning and citizen awareness, as in the case of Helsinki, Finland and Aarhus City, Denmark. From the UF-NBS project in Zagreb, Croatia, having included stakeholders in the development of park-forest management yielded better solutions and avoided possible conflicts. In fact, tree-stewardship in Leipzig, Germany shows that people can become interested in co-funding urban greenery and appropriating it, which can become a blueprint for other cities. The UF-NBS programme in Leeds, UK, demonstrated that ‘community engagement’ provides a far better ownership of the schemes than does the City Council. These beneficial results are now being recognised and accepted across the whole Leeds City Region. Other important stakeholders are NGOs (e.g., public/private participation, associations), which together with other actors can help provide constant funding and support (e.g., state, regional and European funding in Duisburg-Nord, Germany).

Strategic planning of UF-NBS that considers a blend of all the factors mentioned, including connectivity (important in Finland and northern Italy), enables policy makers to address the challenges of climate change, social inclusion, and improving the quality of life in cities, for instance. Enhancing and restoring ecosystem services and biodiversity was found to form the basis of all successful UF-NBS implementations. Any unsuccessful cases do not take this fundamental premise into consideration. This was only found in an outlier case in the city of

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Łódź, Poland. Installation of the Horticultural Exhibition 2024 pavilion and stands implicated cutting down parts of trees, reducing their functions, and the loss of biodiversity. Another interesting lesson learned comes from Ghent, Belgium, where despite the discontent of certain stakeholders for not partaking in the UF-NBS project the project became successful nonetheless, thanks to the sound planning strategy adopted.

Many of the case histories investigated show that UF-NBS projects can be reproduced and applied to other city-regions, whether they be large regional parks or small urban parks and gardens. It does not require a major green space to prove that technical solutions combined with strategic planning can be advantageous from an environmental, economic, and social perspective, as occurred with the urban garden in Bari, Italy. Furthermore, the strategies of the New Urban Master Plan and Decision Support System that will be implemented and applied to various parks in the Metropolitan Area of Barcelona are good examples of transferability from other regions. Regarding transferability, the URBforDAN project in Zagreb, Croatia, with its transnational nature, demonstrates how shared knowledge and know-how among project partner cities can improve decision making on the local level. This is a fine example of how to use local and transnational knowledge to improve UF-NBS management and planning.

Sino-European relevance

Among the 16 case histories reviewed, 10 were found to be comparable for Sino-European relevance, particularly for project size and similarity, planning approaches, environmental challenges, best practices, replicability, and stakeholder involvement. These 10 case histories are: Donau-Auen National Park (Vienna, Austria), Landschaftspark Duisburg-Nord (Germany), “Baumstarke Stadt” (Leipzig, Germany), Park forest Grmoščica (Zagreb, Croatia), Serra de Collserola Natural Park (Barcelona, Spain), Old Town Bay - Vanhankaupunginlahti (Helsinki, Finland), Parco Nord Milano (Milan, Italy), L. Braille Public Garden (Bari, Italy), and Aarhus City (Denmark). Nevertheless, the lessons from both the European and Chinese continental regions can lead to knowledge exchanges and provide inspiration.

The European cities reviewed in our case histories are not comparable to some of the larger Chinese cities, yet they suffer from densification as well. This was particularly the case for the cities of Vienna (Austria), Barcelona (Spain), Aarhus (Denmark) and Leipzig (Germany). Yet, other cities are densifying at a quick pace, such as Ghent and Brussels (Belgium). The methods and readiness to tackle this issue in times of increasing climate change impacts are very significant for both the Austrian and German cities, as well as for the remaining cities included in our analyses. Relevance with Chinese case histories was found for Duisburg-Nord, in Germany, for its renaturing of industrial, steel or mining regions, including sites still operating near the Landschaftspark. This is also true for the post-industrial site of Parco Nord Milano, in Italy. This latter UF-NBS is an example of a multifunctional approach that warrants comparison with Chinese examples (see section 4.2 below). Old Town Bay (Vanhankaupunginlahti) in Helsinki, Finland is also a good example of a multifunctional approach and could be compared to Chinese examples with the management of large water catchment areas and as a preventive measure for countering the harmful effects of climate change. Aside from these approaches, the participatory approach of Park forest Grmoščica, Zagreb, in Croatia for urban forest management and planning, visitor monitoring and knowledge on urban forest governance may be relevant for Chinese partners and stakeholders. Two interesting examples of Sino-European

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relevance are Aarhus City, Denmark, and Serra de Collserola Natural Park, in Barcelona, Spain. Aarhus shares challenges in terms of water flow management and water quality with Ningbo and Shanghai and biodiversity with Shanghai and Beijing. Moreover, both Aarhus and Beijing wish to take action on air pollution and carbon sequestration. For Barcelona, Spain, relevance consists in the possible transferability of good practices, especially in the field of urban planning strategies at various territorial levels; outdoor education is another best practice example of replicability.

4.3 Chinese case histories

The 6 Chinese case histories that have been reviewed for UF-NBS projects are: Hilly Area (Fu Forest Trail), Fuzhou, Fujian Province; Meishan Dongpo Urban Wetland Park, Meishan City, Sichuan province; “Green Wedges” Jiaxing, Zhejiang Province; Green Lungs of the City Project, Yiwu, Zhejiang Province; Plain Area (Afforestation Programme), Beijing, national capital region; and Fushan Ecological Park, Qingdao, Shandong Province. Also for these case histories UF-NBS typology, including ecosystem services and multifunctionality, intended outcomes (principle UF-NBS actions), unintended impacts, as well as lessons to be learned and Sino-European relevance are reported below.

UF-NBS Themes

Typology

The 6 Chinese case histories reviewed also share similar UF-NBS typologies as do the European case histories. These mostly concern forest plantations, as in the cities of Jiaxing, Yiwu, and Fuzhou, green urban areas such as community parks and (historical) gardens in Fuzhou, Meishan, and Beijing. All the Chinese cities feature (ornamental) trees and tree rows, and trees in public parks; in Jiaxing trees were planted in cemeteries as well. Other most commonly implemented UF-NBS found in all Chinese cities are riparian wetlands, such as riverbank green and the wooded banks of ponds and lakes, natural and semi-natural water bodies (in Fuzhou) as well as hydrographic networks (e.g., river corridors in Beijing and Yiwu), bioswales and constructed wetlands (in the case of Yiwu). Both Fuzhou and Yiwu implemented UF-NBS in the form of indigenous ornamental tree and plant species that could prevent plant source pollution (e.g., from willow, pollen). All cities except for Jiaxing have woodland play areas, while only two (Yiwu and Beijing) feature arboretums. In its ecological park the city of Qingdao includes a water management system for environmental education, a seaside playground and a transport infrastructure whose roads connect to the park.

The ecosystem services provided by these UF-NBS types for the cities of Fuzhou, Meishan, Jiaxing, Yiwu, Beijing, and Qingdao are mostly the following: to offer health and wellbeing benefits gained through the use of recreational facilities (including sense of place, aesthetic appeal, and inspiration) and educational facilities for local residents and visitors, to improve water quality, the green/blue landscape, connectivity, sustainability (Meishan, Beijing and Yiwu) and to promote biodiversity conservation. In fact, in Beijing forest cover and urban green space were secured by the plantation of more than 54 million trees. In various parts of the city of Jiayang, whose predominant UF-NBS typologies are forest plantations and trees, all the categories of ecosystem services were found: provisioning (e.g., biodiversity), regulating (e.g.,

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carbon regulation of micro-climate), supporting (e.g., habitats for animal and plant species), and cultural (e.g., recreational value).

Intended outcomes

This section reviews the principle UF-NBS actions of the 6 Chinese case histories that were undertaken to obtain specific intended outcomes. The latter are expressed as UF-NBS ‘valorisation and ‘renaturing’ aspects. In all the Chinese case histories, the main provision of UF-NBS consists in reforestation and afforestation activity (e.g., in Fuzhou, Yiwu and Qingdao) as well as the conservation, restoration and construction of wetlands. For instance, Fuzhou is engaged in the construction of multiple-scale urban parks, Jiaxing in the implementation of new plants and trees as well as in the construction of an urban park, while Beijing carried out tree plantings along rivers, roads and highways to improve water storage and flood management. Another intended outcome shared by the Chinese cities is the restoration of wastelands and wetlands/ponds and the conservation of plants around reservoirs to improve water quality (in Yiwu, Green Lungs of the City Project) and improve the water environment through the construction of urban forest wetlands (in Meishan Dongpo Urban Wetland Park). In the Plain Area (Afforestation Programme) of Beijing, one of the most important intended outcomes is the connectivity of the urban forest system. With this UF-NBS the city aims to connect the old urban forest patches with old vegetated urban parks and woodlands. Connectivity is also an intended outcome, though not the only one, for Fuzhou’s and Qingdao’s urban landscapes and for Yiwu with the reconnecting of ecological corridors. Through wetland restoration and the ‘Green Wedges’ project Jiaxing aims to reduce the intensity of the urban heat island effect. Protecting native tree species is an additional intended outcome for both Yiwu and Qingdao.

Non-UF-NBS actions

For the 6 Chinese case histories, the non-UF-NBS actions were found to be comparable and similar with those of the European case histories. Compared to the vast majority of the European case histories, all 6 Chinese cities presented the same cultural ecosystem service-type non-UF-NBS actions. Recreational and environmental education activities (e.g., workshops on birds, bees or butterfly biodiversity) were found in Fuzhou’s Hilly area (Fu Forest Trail) and the Plain Area in Beijing. Added to these same recreational and environmental education non-UF-NBS actions were workshops on native tree species in a botanical garden and wetlands park in the Green Lungs of the City Project (Yiwu) and in Fushan Ecological Park (Qingdao); the latter also features children’s playgrounds. Sunken wetland sites were used for environmental education in Meishan Dongpo Urban Wetland Park (Meishan), while developing the cultural tourism industry (e.g., catering service) was an added non-UF-NBS action of the Yiwu project. A single non-UF-NBS action was detected for citizen engagement, and this dealt with voluntary tree planting in the “Green Wedges” project of Jiaxing. This non-UF-NBS action is at variance with the European counterpart (6 of 16 case histories). However, like the European case histories, grey infrastructure-like non-UF-NBS actions are common among the 6 Chinese cities, although for the most part they differ. Where European examples typically deal with park/garden and leisure facilities (e.g., foot-/bikepath networks, irrigation and lighting systems, signs at park entrances, park equipment, to name a few), the Chinese examples involve recycling of construction waste/garbage (e.g., using concrete from removed buildings in landscape architecture such as park paths, garden ornaments) as in Fuzhou and Beijing.

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Building new public infrastructure, such as roads, was carried out by both Yiwu and Qingdao, with the addition of a parking lot in Qingdao. Two of 5 case histories in China implemented non-UF-NBS actions related to “green” interventions compared with a fewer number of the 16 European case histories. Specifically, such interventions regarded a field site for an urban field station in the Plain Area of Beijing, and enhancement of the cemetery landscape and recovery of the coastline and beach in Fushan Ecological Park, Qingdao (supporting ecosystem services).

Unintended impacts

The unintended impacts (or trade-offs) of UF-NBS delivery may occur during the various stages of implementation, as certain European case histories have shown. As far as the case histories of China are concerned, it is surprising to discover that basically no unintended impacts were described in the case histories. At the most, one can speak of challenges that were faced and may continue into the future to maintain the implemented UF-NBS. This was found for the three UF-NBS projects of: 1) Fu Forest Trail (Hilly Area) in Fuzhou, 2) Dongpo Urban Wetland Park in Meishan, and 3) Fushan Ecological Park in Qingdao. The conflict Fuzhou is facing concerns the need to manage high-intensity construction requirements brought about by rapid urban development and the conservation of the urban landscape and open green spaces. Therefore, Fuzhou must make good use of its urban mountains and associated forest resources, maintain the characteristics of the urban landscape, and pay greater attention to protection and development. The challenge Meishan Dongpo Urban Wetland Park faces regards how to promote the smooth development of Dongpo Island, connect the east and west sides of the Minjiang River, and thus guide the city to develop eastward and fulfil its maximum value in cross-river development. The park is a typical case of solving the contradiction between constructed land and the original natural environment in the process of urbanisation in China, similarly to Fuzhou. Lastly, the potential challenge for Fushan Ecological Park in Qingdao is the future management of the UF-NBS. In fact, citizen participation was insufficient during the planning and implementation phases of this project.

Lessons learned and transferability

The Chinese case histories have shown similar lessons and transferability among themselves; these deal mostly with preserving/creating UF-NBS in highly urbanised and built-up contexts and the importance of public participation. Dongpo Urban Wetland Park is an example of striking a balance between preservation of the original wetland habitat, creating green leisure space for citizens and the successful integration into the development of the new city area. This UF-NBS case history can also be a reference for other cities that need to solve conflicts during the process of rapid urbanisation. In Jiaxing, the ‘Green Wedges’ project was based on a participatory co-development and co-design process aimed at alleviating the problems of heat and air and noise pollution in the city. The project planners believe that more ways should be explored to encourage the engagement of citizens in the planting, protection and use of trees. The same consideration was made for the project ‘Green Lungs of the City’ of Yiwu, as citizen participation would contribute to protect the environment. This on-going project is considered to be a good field experiment of UF-NBS. Two other UF-NBS projects that consider citizen engagement as a necessary ingredient for success are Beijing’s Plain Area (Afforestation Programme) and Qingdao’s Ecological Park. In the first case, citizen participation could have been stronger during the planning and implementation of this UF-NBS. It was understood that

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citizens need to become more aware of the importance of environmental protection, and the citizens themselves realised that urban forests and trees can improve the quality of their lives and play important roles in the urban ecosystem. Similar findings stood out for the Fushan Ecological Park of Qingdao. This UF-NBS project also showed that citizen participation was insufficient during its planning and implementation, and that citizens' awareness of environmental protection needs to be enhanced. An interesting and different lesson is provided by the Hilly Area of Fuzhou. The Fu Forest Trail introduced new architectural concepts that differ from those used to build traditional urban forest trails; this has made the project famous worldwide, aroused public interest and exerted a huge social impact. This UF-NBS project can serve as a model for designing and replicating similar UF-NBS projects.

Sino-European relevance

A first aspect that becomes evident when considering the importance of European and Chinese case histories is city scale. Two of the Chinese cities considered for review, Fuzhou and Beijing, are mega-cities in contrast with European cities, which can be at most considered metropolises (e.g., Vienna and Milan). Nevertheless, like all other UF-NBS projects in Europe, they aim to improve human wellbeing and meet the demands of citizens. In addition, Beijing seeks to improve the urban green space system to promote urban resilience. The same can be said of the city of Yiwu's 'Green Lungs of the City Project', whose aims are to improve the urban green and blue space systems to enhance urban resilience and meet the demands of citizens, in line with most European cities. The Fushan Ecological Park project in Qingdao, which can be compared with other coastal cities in Europe, is located close to the seaside and with the intended outcomes of restoring the connectivity of coastal mountains and landscapes. This UF-NBS also provides a good example of how to implement and renature UF-NBS in a coastal urbanised area to enhance urban resilience and provide more ecosystem services for citizens or tourists. Jiaxing city's 'Green wedges' project is a model for conserving and expanding existing urban forests and trees in a highly urbanised area.

5 Comparative analysis based on the rapid review method

In addition to the above comparative analysis of the European and Chinese case histories, we hereafter provide a modelling exercise for analysing the data collected across the selected case histories in Europe and China. This exercise consists of a rapid review of all the key words that were found in the case history templates (Task 1.4). As previously explained, 22 case histories (16 from Europe and 6 from China) were collected from project partners and reviewed. For each case history we organised the information into separate themes: ecosystem services, network/connectivity, integration, multifunctionality, inter-/transdisciplinary, renaturing, and social cohesion and biocultural diversity (see Table 2). For the scope of this document we have decided to combine all the information collected regarding the above-mentioned seven themes into two data sets of key words, one for each continent - Europe and China. More specifically, for each continent a set of key words was extracted using the R package "m" (Feinerer et al., 2008), a text mining framework that allows to apply a sequence of functions to the original dataset. The framework used consisted in: (1) splitting each sentence into unique words; (2) converting the text to lower case; (3) removing numbers; (4) removing common English stop words using the word list from the SMART system (Salton, 1971); and (5) removing

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functionality of UF-NBS in European cities. For China, all the key words revolve around the term “urban”, which identifies the specific connection between UF-NBS and large and expanding city settings. Like for Europe, the Chinese case histories provide evidence of the importance of the ecological dimension of UF-NBS, which is explained by frequent key words such as *biodiversity*, *ecological*, *landscape* and *green areas*. Other important key words are *development*, *government*, *activities*, *planning* and *citizens*, which highlight an additional component associated with the engineering side of UF-NBS as well as their economic role in Chinese cities.

A similar pattern emerges from the spider diagram showing the relative predominance of the key words within each of the four macro-categories in Europe and China. Where both continents overlap in the three dimensions of **economic**, **social**, and **ecological**, a clear difference appears in the fourth dimension of **engineering**, which is more predominant in the case of Chinese UF-NBS. This finding could be explained by the large investment being allocated in Chinese cities for large-scale projects related to restoration (e.g., rivers, brownfields, degraded lands) and afforestation, especially to reduce soil erosion and air pollution. The execution and management of these projects truly require an engineering as well as a technological approach, which is probably not yet established in most European UF-NBS.

In summary, this rapid review of key words confirms the existence of a common shared approach for UF-NBS implementations between Europe and China. The analysed case histories from the two continents clearly support the idea of adopting UF-NBS to support ecological functions and ecosystem services at large. The wider scale of implementation for UF-NBS in China strongly requires a more structured approach which, once again, is depicted by the engineering/technological dimension of the projects. An interesting finding is that in both European and Chinese UF-NBS case histories the social component (expressed by key words such as *citizens*, *place*, *education*, *recreation*, *wellbeing*) is also well established and represents one of the targets of new plans and projects for urban regeneration and renaturing. More analyses and research should be undertaken to further explore the commonalities in the emerging field of UF-NBS in Europe and China.

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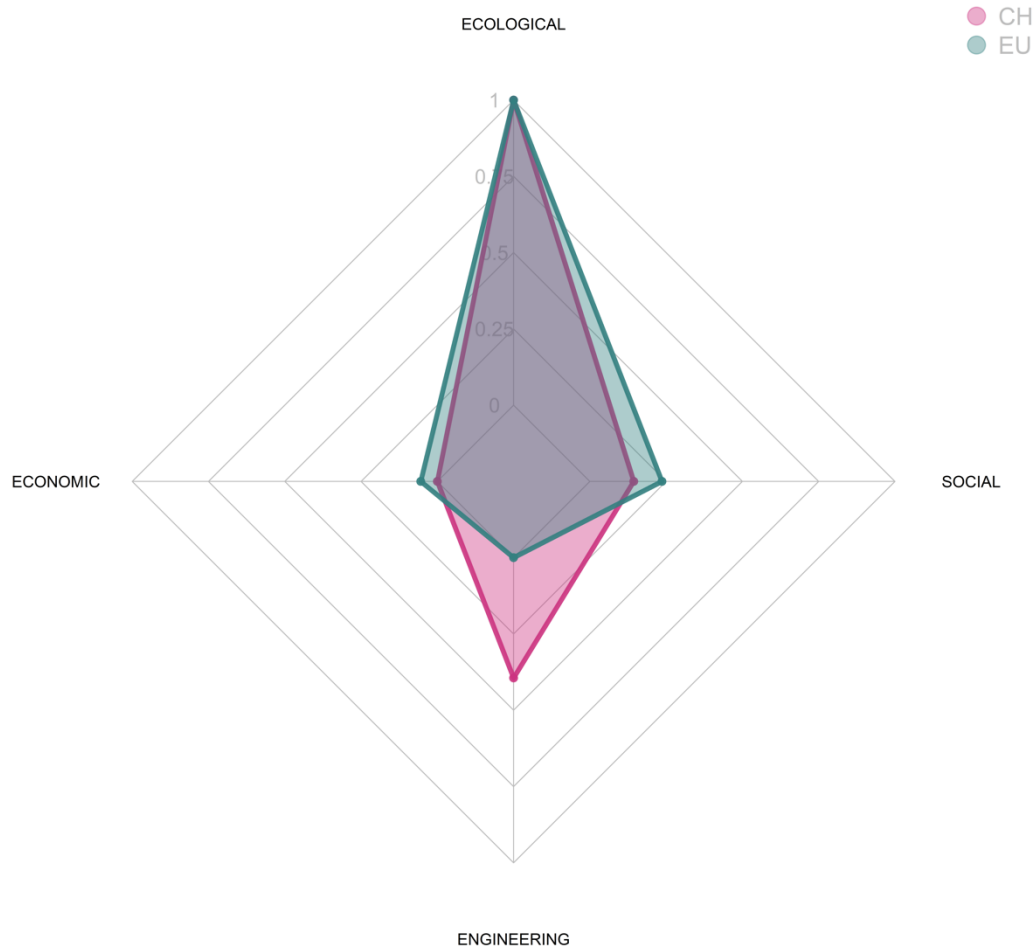


Fig. 3. Spider diagram showing the relative predominance of each of the four macro-categories (1) ecological, (2) engineering, (3) social, and (4) economic for Europe and China.

CONCLUSIONS

The collection and comparison of European and Chinese case studies submitted by CLEARING HOUSE researchers and partners along with the ingathering of knowledge through 22 new case histories represents a hitherto ungathered source of information for comparative study. It is a resource for the next stages of the project. For the most part in this report - D1.2a - the material should be regarded as ‘grey literature’ meaning that it falls outside of academic publishing and includes non-commercial, media, reports and previously unpublished materials. It is to be read alongside D1.2b, the compiled knowledge repository on UF-NBS based on an academic

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literature review. Together these form D1.2 a knowledge repository intended to feed into CLEARING HOUSE Task 1.5; an interdisciplinary analytical framework for UF-NBS.

The literature has revealed similarities (e.g., common goals of citizen involvement) and contrasts (e.g., scale, investment) in respect of UF-NBS in both Europe and China. For instance, the 16 European case histories collected exhibit a number of UF-NBS typologies in common, especially regarding small areas, such as parks and urban green spaces. These typologies extend well beyond those specific to ‘woody green infrastructure’ (i.e., trees and shrubs) and incorporate both semi-natural spaces and managed urban green. From this it can be concluded that UF-NBS do not operate in isolation from other green spaces and the ecosystem services being provided by these derive from allotment gardens through to play areas as well. It is also observable that many of the examples of UF-NBS are associated with waterbodies. This relationship is an area for further research but is tentatively considered to be synergistic. However, it is not clear whether those involved in planning urban forestry or waterbody management are making a cross-connection specifically, but it is conceivable that landscape planners/architects and ecologists are using their professional practice and background knowledge/training to make this connection.

There is also evidence of the concept of multifunctionality derived from the green infrastructure approach when it comes to UF-NBS. The extent of the ecosystem services on offer is nevertheless dependent upon the scale and location of any given example. This is exemplified by the size of any given intervention, for example, if it is a small area or a large area and also whether it is within an urban or peri-urban location. This latter differentiation brings with it different interpretations of urbanity, too, since some of the case histories cover areas influenced by urban centres, while others are not in themselves urban. These spatial distribution and scale factors are locally important, but UF-NBS ecosystem services are also influenced by biogeography, local climate and landscape (including landform). Given that these vary widely within Europe and China any comparison of UF-NBS should be subject to an equivalence quotient.

In Europe a desired outcome of many projects involved with UF-NBS is to raise citizen awareness of nature values and environmental education in general. It is concluded that the drivers for UF-NBS in Europe are at present strongly linked to improving citizens’ health and well-being, enhancing biodiversity, increasing recreational opportunities and improving the aesthetic quality of urban areas. This is not to say that issues such as air pollution and the urban heat island along with the preservation of the urban forest itself are absent, but it seems clear that these are not presently the main drivers. However, enhancing and restoring ecosystem services was found to be the basis of all successful UF-NBS implementations and that unsuccessful examples do not take this premise into consideration. This is a key finding and an area for further research.

Although the scale of the Chinese case histories was larger than the European scale, they do share similar UF-NBS typologies. This is evident with respect to the larger wooded areas in the cities of Jiaying, Yiwu, and Fuzhou, as well as green urban areas such as community parks and (historical) gardens in Fuzhou, Meishan, and Beijing. The same relationship with waterbodies was also found in China as it was in Europe. Indeed, the implementation of UF-NBS in the Chinese case histories is closely associated with riparian wetlands, riverbanks and the banks of

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lakes and semi-natural waterbodies. Also of interest are some of the descriptive words that appear in the Chinese grey literature, such as ‘green-blue landscape’, ‘sense of place’, and ‘inspiration’. As with the typologies most of the same drivers for UF-NBS in Europe can also be found in China such as improving health and well-being, providing recreational facilities and aesthetic appeal. Nevertheless, there is a stronger emphasis in the Chinese case histories on reforestation and conservation alongside reconnecting ecological corridors, reducing the heat island effect, and protecting indigenous tree species along with the aforementioned relationship to wetlands. Therefore, it is possible to conclude that there are more similarities than differences in the approach to UF-NBS between China and Europe, but that scale is a factor along with the ambition for large-scale afforestation in China.

The grey literature produced some unexpected results; for example, no unintended impacts were described in the Chinese case histories, while these trade-offs were commonly reported in Europe. Furthermore, given the top-down planning system in China (starting with the China 5-year plan) there was active participatory planning in Jiaying in the ‘Green Wedges’ project based on a co-development and co-design process aimed at alleviating the problems of heat, and air and noise pollution in the city. The project planners there believe that more ways should be explored to encourage the engagement of citizens in the planting, protection and use of trees. The same consideration was made for the project ‘Green Lungs of the City’ of Yiwu, as citizen participation would contribute to protect the environment. One can conclude that top-down planning does not prevent co-development and co-design of UF-NBS, but equally that the leadership role is still with the municipality; as such, this is very similar to Europe as explored in more detail in D1.4.

Based on the grey literature it can be concluded that while there are cultural differences between Europe and China the similarities in terms of the reasoning behind UF-NBS and the drivers for them are remarkably similar. Projects using UF-NBS (not always by name but by concept) generally aim to improve human well-being and meet the demands of citizens. There appears to be a close nexus between urban green and blue space systems when it comes to UF-NBS. Ecosystem services and the urban green infrastructure approach (especially multifunctionality and networking) are equally evident in project literature. Lastly, researchers working on D1.2a determined that there are questions for future research either within CLEARING HOUSE or in other research projects (see Table 4).

Table 4. Questions for further research identified by D1.2a researchers on UF-NBS based on the current review of grey literature and case histories of UF-NBS practices in Europe and China.

	<p>(1) How do the concepts, strategies and research projects on UF-NBS, ecosystem services, and urban forestry link to real-world cases in Europe and China?</p> <ul style="list-style-type: none"> • While UF-NBS between cases contain many similarities there are also notable differences in project descriptions and implementation; this may suggest that at the ‘project level’ local project managers are responding to a complex of localised factors, • UF-NBS appear to overlap with other forms of NBS provided by different types of biophysical green space; this may be especially so in smaller scale project delivery, • Trade-offs were absent from some case histories; hence, there is a case for more research on trade-offs to ascertain if project-level awareness of trade-offs in UF-NBS is fully recognised.
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	<p>(2) How extensive is the nexus between UF-NBS and waterbodies/management?</p> <ul style="list-style-type: none"> • The nexus between water management and urban forestry seems strong. Hence, is water management a major driver for urban forest creation and a source of funding for the delivery of UF-NBS? • The juxtaposition of water and trees offers aesthetic, amenity and recreational diversity and appears well recognised; however, the proximity of waterbodies can provide irrigation/ground water to sustain evapotranspiration cooling during dry periods, which is a major UF-NBS. To what extent is this being recognised?
	<p>(3) Can UF-NBS findings at a project level be upscaled to a city or regional level?</p> <ul style="list-style-type: none"> • Projects exist at many scales; most are below the city scale, but some are regional and even cross international borders. How might those beneath the city scale link up especially in strategic urban greening plans. • Urban learning labs are normally considered as moderately sized areas used for testing and upscaling; however, could an urban learning lab be a whole city where UF-NBS are considered as part of a canopy management strategy? • Trees and urban forests are a major type of green infrastructure in many cities and are especially valuable in connectivity in urban greening plans.
	<p>(4) Can large-scale afforestation deliver significantly higher levels of UF-NBS?</p> <ul style="list-style-type: none"> • What is the optimal amount of tree (urban forest) cover for projects to aim for to maximise ecosystem services in different contexts, and is this different if the urban forest is considered from a nature-based solution position as opposed to biophysical green infrastructure? • Are there model design guides available to city planners and urban designers to increase UF-NBS and, if not, should these be developed drawing on experience from other projects looking more broadly at NBS?

CREDITS

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APPENDIX 1: GREY LITERATURE

The grey literature in this section has been provided by CLEARING HOUSE researchers and partners. It consists of official reports, plans, programmes, maps, conference proceedings, and scientific publications regarding the case studies of their respective countries. D1.2a draws on the grey literature gathered and on the case histories of UF-NBS projects (Task 1.4). The material in this appendix constitutes the preliminary output – M1.3: ‘Repository on UF-NBS for resilient cities in China and Europe’.

1. EUROPE - Spain

Official documents and reports

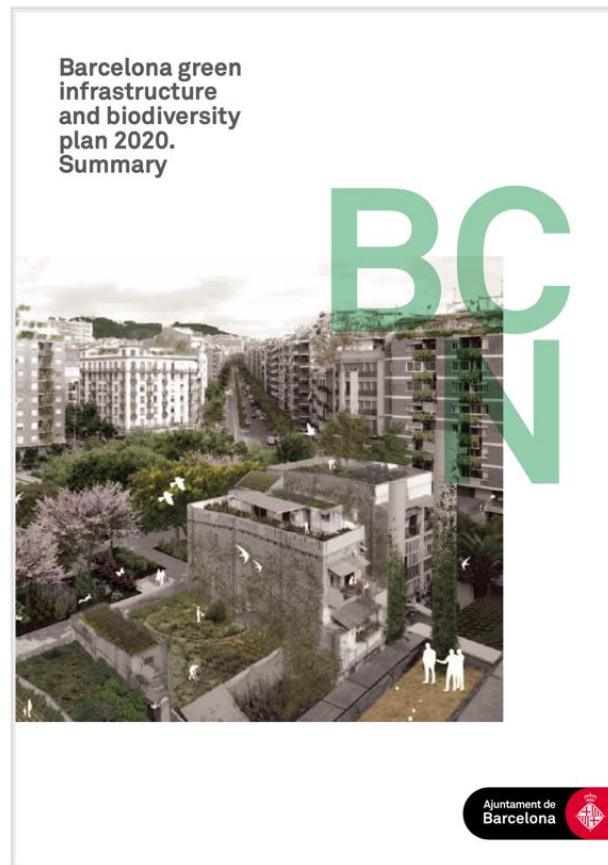
Llobregat River Rehabilitation Project. The Llobregat River (Barcelona) has its sources in the East Southern Pyrenees (Fonts del Llobregat) at an altitude of 2000 m. With a total length of 156.5 km, it drains a basin of 948.4 km², forming a large delta at its mouth in the Mediterranean Sea, after crossing a very densely populated and industrialised region South-west of Barcelona (Tánago and Jalón). The project reach is located in the lower part of the basin, with a total length of 14 km. The floodplain in the project reach is intensively used for agricultural, urban and industrial purposes, and the left bank accommodates several transport facilities (motorway to Barcelona, local roads and the railroad). The Environmental Department of Catalonia demanded an alternative, more environmentally friendly river treatment, which had to be redesigned taking into account many hydraulic constraints but also some ecological issues.

The general objectives for the rehabilitation project were: 1) To improve the morphological and biological structure of the river, to assure its ecological functioning; and 2) To create a continuous fluvial corridor, allowing aquatic and riparian species dispersion, and recreational and cultural activities for human populations along the valley. Some specific objectives were taken into account for the project design: 1) To assure hydraulic conditions able to maintain permanent aquatic communities; and 2) To stabilise the channel and support woody riparian vegetation, adapted to the frequency and magnitude of river floods; and 3) To encourage the use of the river for recreational and cultural activities, promoting its historical, ecological and landscape values. The main measures which were included in the project design were: Creation of a multiple cross-section, including a low flows channel along the river reaches, with a meandering pattern inside the flood cross section; plantations of vegetation areas along the banks of the low flows channel to stabilise its pattern and create an aquatic habitat; plantations of riparian vegetation along the river corridor for habitat creation, recreational purposes and fluvial landscape enhancement; and a pedestrian road along the river corridor to allow walking cycling and access to the recreational areas. (See also: <http://www.amb.cat/en/web/territori/espai-public/espais-fluvials/parc-riu-llobregat?id=21>)

City scale

Within its **Green Infrastructure and Biodiversity Plan 2020** Barcelona is implementing a range of actions to combine nature and the city. Although not explicitly following a systemic NBS approach from the outset, the cumulative effect of various measures is expected to be greater than merely a series of individual projects. For example, actions such as the further development of urban green corridors help to increase connectivity between green areas. In particular, the city recognises urban vegetable gardens as an important component of an urban green infrastructure. Additionally, (based on specific legislation) a network of street trees is also helping to boost resilience and adaptation to climate change, providing direct benefits to urban residents. To the south of the metropolitan area the coastal zone includes an ecosystem of dunes, which is managed by the Metropolitan Administration and provides ecosystem-based adaptation. The peri-urban forest of Collserola, managed by the Consorci del Parc Natural de Collserola, also aims to provide a series of ecosystem services (OPPLA, 2017). *More on “Barcelona - local information”.*

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The City of Barcelona’s ‘Green Infrastructure and Biodiversity Plan 2020’.

Within the recent **Renaturing Barcelona** plan (2020), the city of Barcelona will follow a strategic plan to increase the green quality and quantity in public spaces, through an ecologic management of these areas. The main objectives of this plan are: (i) renaturing the existent green areas, (ii) using ecological management of green to enhance biodiversity, ecosystem functions and services and (iii) creating biodiversity *reservoirs* (i.e. in Ciutadella urban park). Part of the actions related to this policy resulted as an adaptation to the actual public health needs (i.e. less urban green spaces management in some areas, to enhance the colonization of spontaneous vegetation, to favour pollination, species dispersal and biodiversity), but some of them were already present before 2020.

Metropolitan scale

Llobregat River Rehabilitation Project. The Llobregat River has its sources in the East Southern Pyrenees (Fonts del Llobregat) at an altitude of 2000 m. With a total length of 156.5 km, it drains a basin of 948.4 km², forming a large delta at its mouth in the Mediterranean sea, after crossing a very densely populated and industrialised region South-west of Barcelona (Tánago and Jalón). The project reach is located in the lower part of the basin, with a total length of 14 km. The floodplain in the project reach is intensively used for agricultural, urban and industrial purposes, and the left bank accommodates several transport facilities (motorway to Barcelona, local roads and the railroad). The Environmental Department of Catalonia

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demanded an alternative, more environmentally friendly river treatment, which had to be redesigned taking into account many hydraulic constraints but also some ecological issues.

The general objectives for the rehabilitation project were: 1) To improve the morphological and biological structure of the river, to assure its ecological functioning; and 2) To create a continuous fluvial corridor, allowing aquatic and riparian species dispersion, and recreational and cultural activities for human populations along the valley. Some specific objectives were taken into account for the project design: 1) To assure hydraulic conditions able to maintain permanent aquatic communities; and 2) To stabilise the channel and support woody riparian vegetation, adapted to the frequency and magnitude of river floods; and 3) To encourage the use of the river for recreational and cultural activities, promoting its historical, ecological and landscape values. The main measures which were included in the project design were: Creation of a multiple cross-section, including a low flows channel along the river reaches, with a meandering pattern inside the flood cross section; plantations of vegetation areas along the banks of the low flows channel to stabilise its pattern and create an aquatic habitat; plantations of riparian vegetation along the river corridor for habitat creation, recreational purposes and fluvial landscape enhancement; and a pedestrian road along the river corridor to allow walking cycling and access to the recreational areas. (See also: <http://www.amb.cat/en/web/territori/espai-public/espais-fluvials/parc-riu-llobregat?id=21>)

Recent EU Projects related to UF-NBS, ecosystem services/healthy cities (Barcelona and other cities)

SPONFOREST (Biodiversa) (Link: <http://www.creaf.cat/unraveling-potential-spontaneous-forest-establishment-improving-ecosystem-functions-and-services-dynamic-landscapes>)

CERES (Interreg) (Link: <http://www.creaf.cat/es/conectividad-de-los-ecosistemas-forestales-y-riparios-del-espacio-sudoe>)

Naturvation (Link: <https://naturvation.eu/atlas>)

CLEARING HOUSE (H2020)

CONEXUS (H2020, SC5-13-2018 CELAC NBS)

Cities-Health (Link: <http://citieshealth.eu>)

Productive Green Infrastructure for post-industrial urban regeneration (proGireg) (H2020, ISGlobal; Urban regeneration and NBS; link: <https://progireg.eu>)

Valladolid participates in the Horizon 2020 project **URBAN GreenUP**. The objective is to obtain a tailored methodology to support the co-development of Renaturing Urban Plans focused on climate change mitigation and adaptation and efficient water management, and to assist in the effective implementation of nature-based solutions.

Castellon participates in the Horizon 2020 project **Urban Nature Labs (UNaLab)**, which aims to develop a robust evidence base and European framework of innovative, replicable, and locally-attuned NBS to enhance the climate and water resilience of cities. UNaLab focuses on

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urban ecological water management, accompanied by greening measures and innovative and inclusive urban design.

Valencia participates in the Horizon 2020 project **Green Cities for Climate and Water Resilience, Sustainable Economic Growth, Healthy Citizens and Environments (GrowGreen)**. The project seeks to deliver systemic changes to the long-term planning, development, operation and management of seven cities through the use of NBS to deliver quantified improvements in climate and water resilience, social, environmental and economic performance.

Other actions, projects and planning at city level

Horts urbans (Urban gardens). A co-managed initiative initiated by the City Council of Barcelona that aims to involve civil society in defining, installing and managing unused spaces across all districts of the city. The city council provides temporary use for public entities or non-profit associations to develop temporary uses and activities (from one year to three renewable years) in order to promote social activism and cohesion in the neighbourhood. Most part of activities are social urban gardens Link: <http://ajuntament.barcelona.cat/ecologiaurbana/ca/pla-buits>

Blue, Green & Grey_Adapting Schools to Climate Change (Urban Innovative Action).

Link: https://ajuntament.barcelona.cat/qualitataire/ca/noticia/impuls-europeu-a-la-creacio-de-refugis-climaticos-a-les-escoles_718983; <https://uia-initiative.eu/en/uia-cities/barcelona-call3>

Supermanzanas. Public participation, better air quality, increasing green and streets pacification Link: <http://ajuntament.barcelona.cat/superilles/es>

Naturalitzem Barcelona. Enhancing BD, ES, health and well-being (#naturalitzembarcelona; #DonemPasAlVerd; #naturaurbana

Link: <https://ajuntament.barcelona.cat/ecologiaurbana/ca/serveis/la-ciutat-funciona/manteniment-de-l-espai-public/gestio-del-verd-i-biodiversitat/naturalitzacio-dels-espais>

Barcelona policy on children and public spaces. Barcelona City Council developed the Government Measure: Plan for Play in Barcelona's Public Spaces, a strategic policy for 2019-2030. A transversal policy, targeting various levels: (i) broad – Barcelona as a room for play, (ii) middle - schools neighbourhood, city's playgrounds and inner (iii): schoolyards. (Link: <https://institutinfancia.cat/en/projects/ciutatjugable>)

Citizen science projects and educational activities related to UF-NBS

Observatories of biodiversity and other citizen science initiatives related to UF-NBS, biodiversity, and green areas:

- **Ritme natura**, following tree phenology and phenological map. This Citizen Observatory was set up with the help of the H2020 Ground Truth 2.0 project (ending in 2019) (Link: <http://ritmenatura.cat/index-eng.htm>)
- **Natusfera**. (Link: <https://natusfera.gbif.es/?locale=en>)

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- **Jugateca ambiental.** (Link: <http://www.amb.cat/es/web/territori/espai-public/parcs/punts-interes/detall/-/puntinteres/llobregat/6198152/11656>)

The *Metropolitan Urban Master Plan (PDU)*. Objectives: promote the metropolitan capital; naturalize the territory by enhancing the values of the biophysical matrix; improve the efficiency of urban metabolism and minimize environmental impacts; articulate the territory from a polycentric structure; promote active and sustainable mobility by rethinking metropolitan infrastructures; promote social cohesion through housing, public space, equipment and public transport; rehabilitate and recycle urban fabrics; increase urban complexity and habitability; promote the competitiveness and sustainability of the metropolitan economy. Challenges: Green infrastructure, cycles of matter and energy, social and economic development, social cohesion and housing, mobility and transport infrastructures, regulatory framework and metropolitan governance (Maps of ecosystem services of urban parks and principal documents are provided on the weblinks).

Barcelona's Climate Action Plan (2018-2030).

(https://www.c40knowledgehub.org/s/article/Barcelona-s-Climate-Action-Plan-2018-2030?language=en_US#:~:text=Barcelona's%20Climate%20Plan%202018%20%2D%202030,plan%20released%20in%20April%202018.&text=It%20is%20an%20ambitious%20plan,carb on%2Dneutral%20city%20by%202050.)

“*Cities we want*”. An interactive report drafted by ISGlobal researchers detailing the 5 key strategies to building healthy and sustainable cities (<https://www.isglobal.org/en/ciudadesquequeremos>).

Maps of Catalonia, Metropolitan Area of Barcelona, and Province of Barcelona on biomass, biodiversity, and ecological connectivity.

Publications (city, metropolitan, provincial level)

Chaparro L., Terradas J. (2009). *Serveis Ecològics del Verd Urbà a Barcelona*. Informe inèdit, Ajuntament de Barcelona. (Ecosystem services of urban green in Barcelona. Unedited report, Barcelona City Council.)

Basnou C., Gordillo J., Bagarí G., Fuentes L., Pino J. (2019). *Quantificació i cartografia de la biodiversitat, les funcions i serveis ecosistèmics a Catalunya*. Informe inèdit. Generalitat de Catalunya. (Quantification and mapping of biodiversity, the functions and ecosystem services in Catalonia. Unedited report. Generalitat of Catalunya.)

Basnou C., Mestre-Andrés S., Baró F., Langemeyer J., Pino J. (2018). *Definició, Caracterització i Difusió de la Infraestructura Verda de la província de Barcelona en el Marc del Sistema d'Informació Territorial de la Xarxa d'Espais Lliures (SITxell)*. Resum executiu. Informe inèdit. Diputació de Barcelona. (Definition, Characterization and Dissemination of Green Infrastructure of the province of Barcelona within the Framework of the Territorial Information System of the Xarxa d'Espais Lliures [SITxell]. Executive summary. Unedited report, Barcelona Provincial Council.)

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Basnou C., Vayreda J., Pino J. (2014). Serveis ecosistèmics de la infraestructura verda de l'Àrea Metropolitana de Barcelona: primera diagnosi. Informe inèdit. (Ecosystem services of green infrastructure of the Metropolitan Area of Barcelona: first diagnosis. Unedited report.) Barcelona Regional.

Basnou C., Baró F., Gómez-Baggethun E., Guardia A., Langemeyer J., Vayreda J., Pino J. (2016). Anàlisi dels serveis ecosistèmics de la província de Barcelona i proposta d'una infraestructura verda, en el marc del Sistema d'Informació Territorial de la Xarxa d'Espais Lliures (SITxell). Informe inèdit, Diputació de Barcelona. (Analysis of ecosystem services of the province of Barcelona and proposal of a green infrastructure, within the framework of the Territorial Information System of the Xarxa d'Espais Lliures [SITxell]. Unedited report, Barcelona Provincial Council.)

Basnou C., Baró F., Langemeyer J., Castell C., Dalmases C., Pino J. (2020). Advancing the green infrastructure approach in the Province of Barcelona: integrating biodiversity, ecosystem functions and services into landscape planning. *Urban Forestry & Urban Greening*, Volume 55.

Pino J., Basnou C. (2014). Anàlisi de les pressions sobre la biodiversitat a l'Àrea Metropolitana de Barcelona i de les seves tendències futures. Informe inèdit. (Analysis of the pressures on biodiversity in the Metropolitan Area of Barcelona and of future trends. Unedited report.) Barcelona Regional.

Pino J. (2007). Primera proposta de bases cartogràfiques, criteris i mètodes per a l'avaluació de l'estat ecològic del bosc a l'àmbit SITxell i de les seves tendències a curt termini. Informe inèdit, Diputació de Barcelona. (First proposal of cartographic bases, criteria and methods for the evaluation of the ecological status of the forest area in the SITxell framework and of short-term trends. Unedited report, Barcelona Provincial Council.)

2. Belgium

Official documents and reports

Nature Report 2016 – 'Putting ecosystem services to work' Technical Report – Chapter 4. Valuing land use change in Flanders. This report presents a scientific study towards the integrated assessment of land use changes, building on two actual land use processes in Flanders (forest expansion and erosion control). For every process, three alternative scenarios have been developed, which have been assessed along ecological, societal and economic indicators. The three forest extension scenarios include:

- maximising conservation of forest habitats and species of European importance (habitat and bird directives)
- maximising urban forest availability to the population (focus on recreation and afforestation close to urban centres)
- maximising carbon sequestration

The Nature Value Explorer Manual: Nature Value Explorer has been developed by the Department for the Environment of the Flemish Authorities. It focuses on pragmatic methods to value ecosystem services. They help everyone (land managers, planners, national and local

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authorities, non-governmental organisations and active citizens) who want to map the socio-economic importance of ecosystems. It is important to understand that this study values a marginal change in ecosystem service provision, but does not measure the total value of certain ecosystems. The figures do inform policy makers about welfare gains or losses generated by the impact of a project or policy on the delivery of ecosystem services.

Urban forests in Flanders, Belgium: Report by the Flemish NGO 'BOS+' (2018). 'BOS' has provided an assessment of the progress of urban forest realisation (new afforestation) in Flanders, in Northern Belgium. The increasing appreciation of urban greenery and (peri-) urban forests is a clear social trend. The importance of urban forests has already been demonstrated on many occasions, with increasing attention being given to the health-promoting effects of sufficient (accessible) urban green space. However, an actualisation study on the achievements of (peri-)urban forests in Flanders shows that the developments in field and policy are leading toward an evolution which is diametrically opposed to this. The study clearly shows that the realisation of (peri-)urban forests has stagnated to a very large extent since a first study in 2011. With the exception of the city of Ghent as a unique, very positive outlier, no other city or municipality in the past 7 years has been able to develop more than 30 ha of urban (peripheral) forest. Only 8 smaller urban regions realised in those period more than 10 ha of forest extension, while 22 towns and cities have a limited area (0 - 10 ha) of forest expansion. In 32 of the 62 municipalities surveyed between 2011 and 2018 there was no forest expansion at all. In the past 7 years, therefore, less than 10% of the targeted (peri-)urban forest has been realised.

This report examines the social importance of (peri)urban forests and their international and Flemish policy context. The methodology of this study is explained, after which the results for each surveyed municipality are discussed. In order to give (peri-)urban forests the attention they deserve, and to achieve the much-needed expansion of forests in practice, a number of concrete recommendations were also formulated. For example, it is crucial that qualitative and quantitative objectives for the realisation of (peri-)urban forests are once again set in the respective policy visions, with a clear deadline and proper monitoring tool.

To support both local authorities and private initiatives, there is a need for an overarching support framework offered by the Flemish Government. This requires the necessary financial resources. These could be made available through a forest expansion fund or by a concrete allocation of a share from the existing municipal fund or investment fund. But also the removal of administrative or legal obstacles (e.g., from municipal funding or land use permits) should be given priority. Today, for example, municipalities are rewarded when they have more inhabitants or get businesses on their territory, but not when they provide additional (peri-)urban forest on their territory.

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Progress report on urban forest realisation in Flanders, Belgium.

Publications

Urban Environmental Quality: Exploring and analysing nature-based design solutions for Brussels. https://issuu.com/m-ayas/docs/kawa_marie-caroline_master_thesis

Examining the policy needs for implementing nature-based solutions in cities: Findings from city-wide transdisciplinary experiences in Glasgow (UK), Genk (Belgium) and Poznań (Poland) <https://doi.org/10.1016/j.landusepol.2020.104688>

Agence TER (2016). Het reliëf van de Molenbeekvallei als basis voor een productief park. Metropolitan Landscapes: Open ruimte als basis voor stedelijke ontwikkeling -Espace ouvert, base de développement urbain. A. Loecx, E. Corijn, F. Persyn et al. Brussels, Vlaams Bouwmeester: 191.

Towards an ecological approach for sustainable urban planning: the case of the Brussels-Capital Region <https://difusion.ulb.ac.be/vufind/Record/ULBDIPOT:oai:dipot.ulb.ac.be:2013/288316/Holdings>

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Hamdi, R., H. Van de Vyver, R. De Troch and P. Termonia (2013). "Assessment of three dynamical urban climate downscaling methods: Brussels's future urban heat island under an A1B emission scenario."

Stessens, P., A. Blin, WIT Architecten and OSA (2016). Het waterlandschap van de zuidelijke Zennevallei - Le paysage aquatique du sud de la vallée de la Senne. Metropolitan Landscapes: Open ruimte als basis voor stedelijke ontwikkeling - Espace ouvert, base de développement urbain. A. Loeckx, E. Corijn, F. Persyn et al. Brussels, Vlaams Bouwmeester: 191.

Stessens, P., A. Z. Khan, M. Huysmans and F. Canters (2017). "Analysing urban green space accessibility and quality: A GIS-based model as spatial decision support for urban ecosystem services in Brussels." *Ecosystem Services* **28**: 328-340.

Stessens, P., A. Z. Khan, M. Huysmans and F. Canters (submitted). "Urban green space qualities: An integrated approach towards GIS-based assessment reflecting user perception." *Land Use Policy*.

3. Sweden

Official documents and reports

Urban Woods for People (LIFE ENV/S/000868, EU LIFE-ENVIRONMENT PROJECT REPORT). The documentation of the project consists of two parts: 1) a technical report and 2) a layman's report. The latter is intended for a wider readership and explains the project objectives and results obtained to decision-makers and other non-technical partners, including those interested in increasing the recreational value of urban woodlands. The final project report, including the various subprojects, can be found on www.svo.se/urbanwoods.

Other sources focusing on NBS and biodiversity

The Regional Biodiversity Agency web portal featuring a collection of actions on climate and biodiversity using nature-based solutions. The Regional Biodiversity Agency in Île-de-France, France, participated in the 21st session of the Conference of the Parties on Climate Change (COP21) in Paris in 2015. On this occasion, the Agency produced a collection of proposals to encourage the deployment of NBS in urban and forested areas for climate change mitigation and adaptation. The NBS concept sheds new light on strategies to combat climate change. It refers to actions to preserve, restore and reclaim ecosystems since they contribute to both mitigation (carbon capture and storage) and adaptation (protection against storms, floods, landslides. Ground). NBS for climate change in Paris can be accessed through the following link: <https://www.arb-idf.fr/publication/recueil-dactions-climat-et-biodiversite-les-solutions-fondees-sur-la-nature-2015>.

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French Regional Biodiversity Agency report for deploying NBS.

Regional guides to building with local wood. The guides for elected officials have been published by the regional unions of Forestry Communes: http://www.fncofor.fr/construire-bois-local-guides-regionaux-22_2805.php

Guide for integrating biodiversity in forest management:
https://agriculture.gouv.fr/sites/minagri/files/documents/pdf/Guide_PFB.pdf

Forest management and climate change: <https://www.onf.fr/onf/+/7^2::lonf-prepare-lavenir-des-forets-publiques.html>; <https://www.onf.fr/+/40::le-label-foret-dexception-une-demarche-nationale.html>

4. France

Official documents and reports

UICN. Rapport SFN et changement climatique. (NBS and climate change report) 2018. France. Link: <https://uicn.fr/wp-content/uploads/2018/06/brochure-sfn-mai2018-web-ok.pdf>

UICN. Rapport SFN et eau 2020. (NBS and water report 2020) 2019. France. Link: <https://uicn.fr/wp-content/uploads/2020/01/sfn-light-ok.pdf>

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ONERC. *Rapport SFN 2019. (NBS report 2019)* 2019. France. Link: https://www.ecologie.gouv.fr/sites/default/files/ONERC_Rapport_2019_SfN_WEB.pdf

Agence régionale de la biodiversité en Île-de-France. *Climat : la nature source de solutions en Île-de-France. (Regional biodiversity agency in Île-de-France. Climate: nature as a source of solutions in Île-de-France)* 2015. France. Link: https://www.arb-idf.fr/sites/arb-idf/files/document/ressources/natureparif_-_propositions_cop21_fr_-_web_planches.pdf

MTES. *Plan national d'adaptation au changement climatique. (National climate change adaptation plan)* 2017. France. Link: https://www.ecologie.gouv.fr/sites/default/files/2018.12.20_PNACC2.pdf

Capitale française de la biodiversité. Climat: la nature source de solutions. (French capital of biodiversity. Climate: nature as a source of solutions) 2019. France. Link: <http://www.capitale-biodiversite.fr/sites/default/files/experience/documents/cfb2020-recueil-actions.pdf>

ADEME. *Végétaliser: agir pour le rafraîchissement urbain. (Vegetate: Acting for urban refreshment)* 2020. France. Link: (not valid)

Capitale française de la biodiversité. Nature en ville et changements climatiques: recueil d'actions de collectivités en faveur de la biodiversité. (French capital of biodiversity. Nature in the city and climate change: collection of community actions in favour of biodiversity) 2015. France. Link: http://www.capitale-biodiversite.fr/sites/default/files/pages/documents/Recueil_Action_capitale_2015.pdf

Publications

Office National des forêts. *Forêt Urbaine: book de références. (Urban Forest: reference book)* 2020. Available at: <https://www.onf.fr/produits-services/+/83b::foret-urbaine-book-de-references.html>

LeMonde. *Urbanisme: la poussée des villes-forêts divise les architectes paysagistes. (Urban planning: the growth of forest-cities is dividing landscape architects)* 2020. Available at: https://www.lemonde.fr/economie/article/2020/11/14/urbanisme-la-poussee-des-villes-forets-divise-les-architectes-paysagistes_6059724_3234.html

Nature4Cities. *Technical Data Sheet - Urban Forests as NBS.* Available at: <https://www.adaptation-changement-climatique.fr/sites/cracc/files/fichiers/2020/03/Foret%20urbaine.pdf>

ADEME. *Aménager avec la nature en ville. (Developing with nature in the city)* 2018. Available at: <https://www.ademe.fr/amenager-nature-ville>

ADEME. *Actions d'adaptation au changement climatique en France aujourd'hui. (Actions to adapt to climate change in France today)* 2017. Available at: <https://www.ademe.fr/actions-dadaptation-changement-climatique-france-aujourd'hui>

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ADEME. *Rafraichissement des villes: De quelles connaissances avons-nous besoin? (Renovating Cities: What Knowledge Do We Need?)* 2017. Available at: <https://www.ademe.fr/rafraichissement-villes-connaissances-besoin>

Urban Forests. *La méthode Miyawaki – Chiffres & concepts. (The Miyawaki Method - Figures & Concepts)* 2020. Available at: <http://urban-forests.com/wp-content/uploads/2020/05/Urban-Forests-Compilation-%C3%A9tudes-Miyawaki-b%C3%A9n%C3%A9fices-VF.pdf>

Forêt méditerranéenne. *Forêts et villes: solutions fondées sur la nature dans les zones urbaines (Forests and cities: nature-based solutions in urban areas)*. 2020. Available at: https://www.researchgate.net/publication/339363967_Forets_et_villes_solutions_fondees_sur_la_nature_dans_les_zones_urbainesForest_and_Cities_forest-based_solutions_in_urban_areas

The Conversation. *Les “forêts urbaines”, essentielles aux villes de demain. (“Urban forests”, essential for the cities of tomorrow)* 2018. Available at: <https://theconversation.com/les-forets-urbaines-essentielles-aux-villes-de-demain-94335>

ADEME. *L'arbre en milieu urbain, acteur du climat en région Hauts-de-France. (Trees in urban areas, a climate actor in the Hauts-de-France region)* 2018. Available at: <https://www.ademe.fr/larbre-milieu-urbain-acteur-climat-region-hauts-france>

5. Germany

Official documents and reports

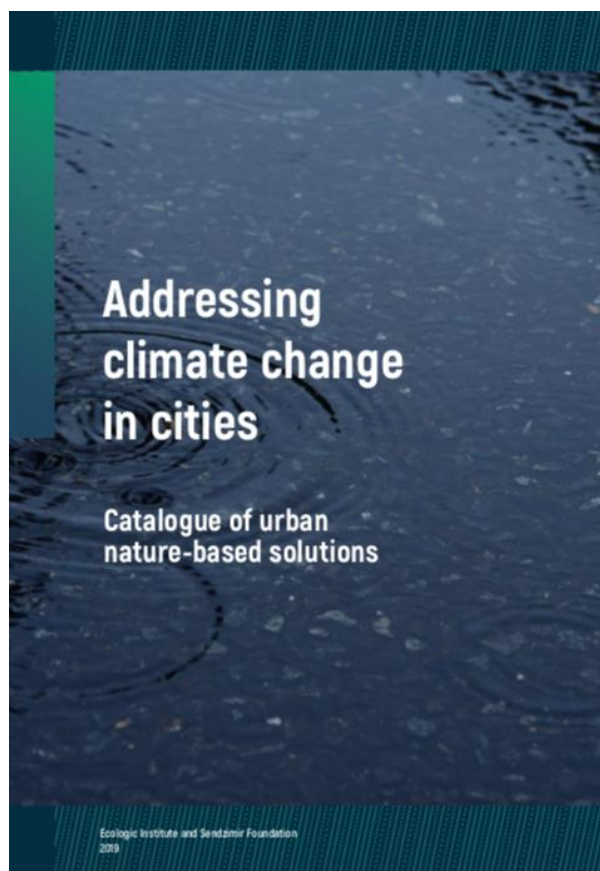
The *NRW Green Infrastructure Call (MKULNV & EFRE-Verwaltungsbehörde NRW, 2020)* is aimed at municipalities, municipal associations and municipal federations from North Rhine-Westphalia (NRW) which are seeking to network and optimise open spaces up into the urban periphery in order to achieve an improvement in climatic and environmental conditions and quality of life as well as environmental justice in the neighbourhoods, districts and urban periphery. With this objective, social exclusion processes are also to be counteracted by a green infrastructure upgrading neighbourhoods and urban districts. Funding is provided on the basis of integrated municipal action concepts from which appropriate implementation projects are derived.

Federal State plans and policies; the *TU Dresden Research Report*: These papers present the results from the research project: “Ecological urban renewal by creating urban forest areas on inner-city sites in a change of use - a contribution to urban development in Leipzig.” The different modules are: Population, Recreation, Soil and water balance, Fauna, Flora, Urban climate, and Urban redevelopment.

Addressing climate change in cities. Catalogue of urban nature-based solutions (2019). This catalogue responds to the gaps present in NBS applications as a climate mitigation and adaptation solution for cities. It has been produced within the “Climate NBS Poland” project and supported by the European Climate Initiative (EUKI) of the German Ministry of Environment. Case studies focus on NBS which have been deployed in Germany. However,

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these exemplify high climate mitigation potential and applicability across a range of urban contexts. Information on cost-effectiveness and NBS' potential to mitigate climate change are presented alongside implementation guidelines. The selected case studies show how NBS can be used in combination with one another to create systemic solutions that address multiple urban challenges in parallel – at sites as small as a playground or as large as an entire city. The catalogue is designed to support planners, designers and landscape architects in various sized urban areas in Europe and beyond in applying NBS instead of or alongside traditional approaches. It is complemented by “Addressing climate change in cities: Policy instruments to promote nature-based solutions”, a guide on policy instruments that can be used to foster NBS uptake in cities.



Addressing climate change in cities. Catalogue of urban nature-based solutions', 2019.

MULNV, n.d. Report on the situation and development of forestry in North Rhine-Westphalia.

Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (BMUB), 2017. The report summarizes ten fields of action to pave the way towards greener cities.

Bundesamt für Naturschutz (BfN), 2017. The document describes the concept of Green Infrastructure at federal level, as embedded in processes at EU level for the establishment of green infrastructure. It identifies elements and functions of green infrastructure in Germany and provides a brief introduction into currently planned concepts or strategies (Landscapes of

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national importance, “Blue Band Germany”, National action plan on protected areas, protection of Baltic/North Sea).

Senatsverwaltung für Stadtentwicklung und Umwelt, 2015. The leaflet informs on the positive benefits of trees in the city and on Berlin’s goal to plant 10000 additional street trees by 2017 (Stadtbaumkampagne). It provides information on progress as of late 2015, with 5000 trees planted.

Publications

Jay, Selter, Wurster, & Schraml, 2016. Guidelines for action for urban forests in NRW. This paper presents the results from an interdisciplinary discussion on forest ecosystem services. It is a reflection on the urban forest uses of tomorrow and their design in North Rhine-Westphalian (NRW) cities.

Zehfuß, 2017. This presentation covers ecosystem services of urban forests using the example of forests in the city of Essen. Furthermore, it presents the process in the form of a step by step concept which is transferable in other municipalities. Also, an overview of derivation and presentation of the ecosystem services is given.

Claßen et al., 2012. Overview of the research conducting by the research group “StadtLandschaft & Gesundheit”. Current and future socio-demographic processes in Germany and the associated developments in the settlement area offer opportunities to use spaces that become free in the city in the sense of relationship-based health promotion. This paper outlines research on governance of urban blue areas, societal perceptions on urban green and potential of urban greenspace for public health.

Claßen & Völker, 2015. Urban green and blue spaces have a great potential with regard to the protection and promotion of human health and well-being. Based on the most recent evidence on associated health effects, requirements and perspectives are formulated for further development of urban green and blue spaces in the context of integrated, healthy urban planning.

Dushkova, D., Haase, D., 2020. Methodology for development of a data and knowledge base for learning from existing nature-based solutions in Europe: The CONNECTING Nature project. *MethodsX*. 7, 101096.

6. Austria

Official documents and reports

Strategies and programmes

The Urban Development Plan Vienna (STEP 2025) provides a future direction of Vienna city development in different spheres. In this planning document the significant focus is placed on the urban planning that include green and open spaces as well as extensive building greening and urban trees for recreation, leisure, ecological diversity and nature-based responses to the climate change challenge. All this is presented in the technical concept for green and open spaces of STEP 2025. In his technical concept, the goals for green and open space planning are

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specified and minimum standards and indicators for supplying the population with urban greenery are specified, which must be applied in urban development areas in any case. For areas that are already densely built-up, the technical concept provides suggestions for compensatory measures in the form of greening of building and multiple use of existing green spaces. The technical concept describes the economic, ecological and social importance of Vienna's urban greenery in the form of a catalogue of arguments (MA 18, 2020).



The Urban Development Plan of Vienna (STEP 2025).

The Urban Heat Island (UHI) strategy plan of the Vienna environmental protection department describes in detail different ways to counteract the heat islands in the city of Vienna and presents strategic and concrete project-oriented measures. Eight measures out of the ten presented rely on nature-based solutions, such as securing and expanding green and open spaces and the stock of trees, networking the existing open spaces, greening buildings, increasing the proportion of water, unsealing of areas and rainwater evaporation and seepage. All measures are assessed in the strategic plan with regard to their effect on micro- and mesoclimate, biodiversity and quality of life as well as their economic efficiency in maintenance and construction. Green and blue infrastructure, i.e. urban greenery and water, are classified in the UHI strategy plan as particularly effective for reducing heat islands, and as particularly economical and valuable due to the multiple benefits for the environment and society (MA 22, 2020).

Smart City Wien framework strategy was developed in 2014 by the Vienna City Council. It is produced in the participatory process lead by the Vienna Department for Urban Development and Planning and broad stakeholder participation. It is a long-term umbrella strategy with

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specific goals for changes in the energy, mobility, health and building sectors as well as for the environment and innovations in Vienna, which are to be implemented in stages by 2050. The aim is to significantly reduce the consumption of resources in the city while at the same time maintaining the quality of life and safety for the residents. Nature-based solutions are addressed in the Smart City Wien framework strategy under the target of "ensuring quality of life at the highest level". Specifically, it is stated that the 50% green area and measures such as planting city trees, greening facades and roofs, new buildings with green flat roofs and neighbourhood gardens, soil protection and unsealing have significant effects on health promotion, air quality, increasing biodiversity and stabilizing the temperature (Magistrate of the City of Vienna, 2020).

The Climate Protection Program of the City of Vienna, valid until 2020, contains 37 programs of measures. The "Urban Structure and Quality of Life" program addresses nature-based solutions in the form of green and open spaces and green buildings. In the "Improvement of the Building Envelope" program, the green roof measure for building cooling occurs only marginally (MD-KLI, 2009).

The city of Vienna's *Forest Development Plan* should also be mentioned here, as the issue of sustainability is linked with the history of forest management. Actually Vienna forests represent a nature-based solution to a wide range of urban challenges. Forest Development Plan is published every ten years and shows the useful, protective, welfare and recreational effects of Vienna's total forest area of 8,326.68 hectares (corresponds to 20.1%). In Vienna, the wellbeing and recreational functions predominate (98%). The protective function is given to 1.5% of Vienna's forest areas which are described as "remarkable for a large city" (BMLFUW, 2017).

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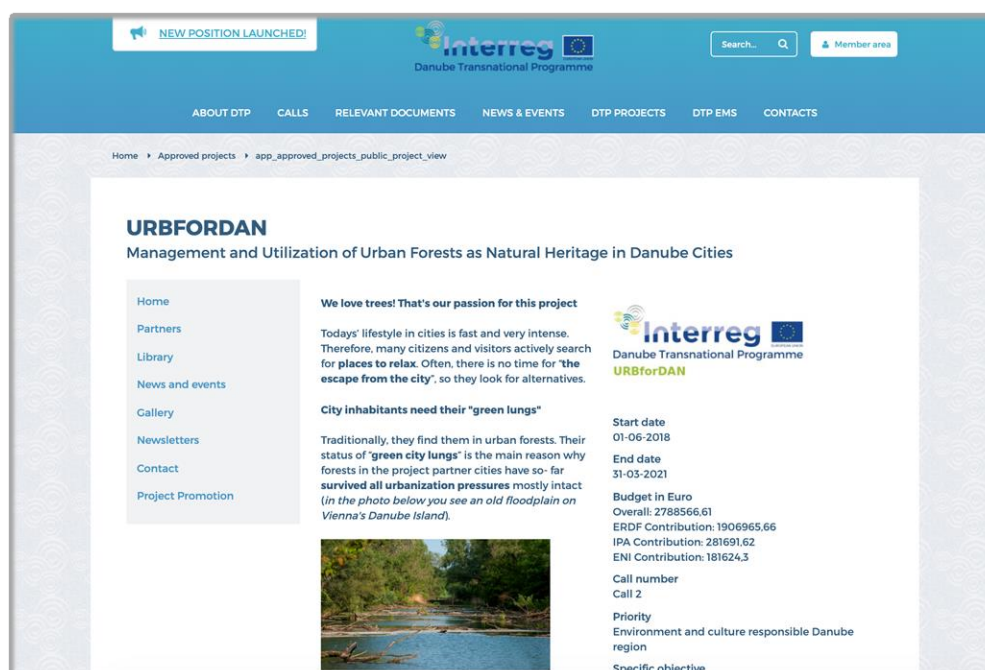
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Schrenk, C. 2017. Die Stadt sät Nachhaltigkeit. (The city sows sustainability) (https://www.academia.edu/39110934/Die_Stadt_sät_Nachhaltigkeit_Bachelorseminararbeit_Naturbasierte_Lösungen_in_Wien_für_Nachhaltigkeit_Resilienz_und_Klimawandelanpassung_im_Rahmen_der_globalen_Ziele_für_nachhaltige_Entwicklung_der_Agenda_2030) (accessed 09 October 2020)

7. Croatia

Official documents and reports

URBforDAN - Management and Utilization of Urban Forests as Natural Heritage in Danube Cities (Zagreb). Two documents are featured in the project: the URBforDAN Guidelines on Participatory Approach and Overall Stakeholder Analysis with key stakeholder profiles. The first focuses on the Participatory approach (PA), which incorporates public participation as an integral part of the decision-making process. In practice it enables ordinary people to play an active and influential role in decisions which affect their lives. PA was effectively used during workshops held in all seven URBforDAN cities. The second document focuses on Key Stakeholder Profiles which were developed by each project partner of the URBforDAN project to ensure in-depth understanding of their key stakeholder groups on the city level. It also channels all relevant information gathered by questionnaires for urban forest users and owners into the planning process of Integrated Multi-use Management Plans.



URBforDAN - Management and Utilization of Urban Forests as Natural Heritage in Danube Cities project - Zagreb.

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Strategy and action plan of green infrastructure of the city of Zagreb – under development, working group established in May 2019. Currently in the process of environmental impact assessment (<https://www.zagreb.hr/strateska-procjena-utjecaja-na-okolis-strategije-z/169791>). Key principles: quality of life of residents and visitors, development and enhancement of urban green infrastructure, protection of biological and landscape diversity, climate change mitigation and adaptation. Strategic goals: protection, enhancement and sustainable management and governance of natural and cultural heritage in urban and peri-urban areas (GREEN CITY); green infrastructure will encourage sustainable growth and development to secure higher quality of living (SUSTAINABLE CITY) and will secure climate change mitigation (HEALTHY CITY).

Study and strategy of green infrastructure development of the city of Sisak (2018). Developed by the private company 3E projekti d.o.o. in collaboration with the Faculty of Agronomy of the University of Zagreb, department of landscape architecture.

Link to the document in Croatian. Link: https://sisak.hr/wp-content/uploads/2019/02/Studija_Strategija_ZI_Sisak_web.pdf

Study and strategy of green infrastructure development of the city of Križevci until 2027. Developed by the private company Vitaprojekt d.o.o. Link to the document in Croatian. Link: <https://krizevci.hr/wp-content/uploads/2020/10/Studija-i-Strategija-razvoja-ZI-Grada-Krizevaca-do-2027.pdf>

Strategy of climate change adaptation in the Republic of Croatia for the period 2040 with the 2070 outlook. The strategy acknowledges green infrastructure as a means to climate change adaptation, including in urban areas. Link to the document in Croatian: https://narodne-novine.nn.hr/clanci/sluzbeni/2020_04_46_921.html

Publications

Topics: urban green infrastructure; review of urban forest research in the Mediterranean; soil assessment in urban parks; green space research and practice in Croatia; implementation of green infrastructure to minimise climate change; survey on urban nature park users' preferences and perceptions of crowding; selection of plants/trees for public spaces and buildings; urban forests in residential land use; challenges to governing urban green infrastructure in Europe.

8. Slovenia

Official documents and reports

Ljubljana 2025 Vision. Since 1986, the city of Ljubljana has been without any comprehensive spatial planning tool. Therefore, the Municipalities and City of Ljubljana decided to adopt and draft (in 2007) the its urban planning instrument *Ljubljana 2025 Vision*, emphasising the spatial and social values the city has been promoting ever since. The document points out three fundamental guidelines for the development of the city:

- Ljubljana as an ideal city – Ljubljana will remain an attractive, people-friendly city full of greenery (75% of the city is covered by green areas);

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- Ljubljana as a natural city – the city will provide direct access to open areas and the connectedness of the landscape system;
- Ljubljana as the all-Slovenian metropolis – the city will continue to promote safety and tolerance, strengthen diversity, and further improve the existing high quality of living.
- In addition to development guidelines, the vision also defined 93 tangible development projects. <https://www.ljubljana.si/en/ljubljana-for-you/urban-planning/ljubljana-2025-vision>
- In 2016, the City of Ljubljana adopted the Sustainable Urban Strategy of the City of Ljubljana, a document representing the joint urban platform of sectoral development programmes, policies and plans of the City of Ljubljana for sustainable development. Above all, it is the strategic basis for the medium- and long-term development of Ljubljana. It furthermore includes the implementation of the new urban policy of the European Union and the utilisation of European funds dedicated to urban development, which is implemented through the mechanism of Integrated Territorial Investments in the Republic of Slovenia. Link: <https://www.ljubljana.si/en/ljubljana-for-you/urban-planning>

The *Municipal Spatial Plan (MSP)* is divided into two separate documents: MSP Strategic and MSP Implementation. It is a joint effort in cooperation with various urban institutions, the wider professional public and residents; both documents were adopted in 2010 and represent the central spatial planning documents of the City of Ljubljana. The fundamental strategic objectives of the spatial development of the City of Ljubljana are to maintain and strengthen the spatial, natural and cultural values of the city as well as its wider surroundings, which mean the identity and potential for high-quality city development and quality of living. Link: <https://www.ljubljana.si/en/ljubljana-for-you/urban-planning/municipal-spatial-plan>

Ljubljana - European Green Capital 2016. Links to the documents: <https://ec.europa.eu/environment/europeangreencapital/winning-cities/2016-ljubljana>, <https://www.ljubljana.si/en/ljubljana-for-you/european-green-capital-2016/>.

Ljubljana for you. Report of the European Green Capital 2016 project: <https://www.ljubljana.si/assets/Uploads/Casopis-porocilo-310x460-ENG-WEB3.pdf>.

Publications

Topics: urban forestry case study; residents and citizens' perceptions of urban forests/green spaces; urban ecosystem governance; ecosystem services and biodiversity of urban green areas; influence of urban green (trees) on runoff; green connectivity for maintaining of biodiversity and well-being; Urban heat islands in relation to green land use.

9. Serbia

Official documents and reports

General Regulation Plan of the Green Area System of Belgrade (Official Gazette RS 110/19)
The General Regulation Plan of the Green Area System of Belgrade is the last phase of the "Green Regulations of Belgrade" Project and represents a meaningful, complex and important

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step in the management of green areas. The concept of the planning solution is formed on three levels, where the preservation and enhancement of the existing green areas is imperative, and the planning of new green areas is aiming for European standards. In the context of the sustainable development of Belgrade, the plan is based on the principles of connecting green areas, achieving multifunctionality and accessibility, preserving the character of the landscape and improving biodiversity. Link: <http://mapa.urbel.com/Silverlight/1547>

Climate Change Adaptation Action Plan with Vulnerability Assessment. The starting points for the development of the “Climate Change Adaptation Action Plan with Vulnerability Assessment” were the goals and principles defined within the regional project “Climate Change Adaptation in the Western Balkans”. In this plan green spaces are identified as highly vulnerable to almost all the effects of climate change. The plan presents all current and future vulnerability or green areas to the effects of climate change and provides a detailed overview of challenges that various green space elements in the city will face.

Link:

https://www.beograd.rs/images/data/490a945e291ea727dd293493f6b7f187_6038551926.pdf

Afforestation Strategy of the Belgrade Area. The afforestation strategy of the Belgrade area includes the development of activities to enhance the quality of the environment, protect biodiversity and the rational use of forest resources. The goal of the strategy is to implement measures and other strategies in the field of environmental protection, i.e. nature protection, water protection, protection of the city's green areas, as well as forestry development in the territory of Belgrade. The unfavourable state of forest cover in the area of Belgrade requires planning major works on the afforestation of bare lands, anthropogenically destroyed forest complexes and agricultural areas affected by erosion, as well as the planning of protective forests and the rehabilitation of degraded terrains, landfills and former mine areas. The strategy's aim is to connect existing forest complexes with new forests, windbreaks and green corridors on vacant land, since well-connected urban greenery can provide useful public forest functions and impact the creation of a healthy urban environment. Link: https://www.beograd.rs/images/file/a0b89a674852be8feba7aef3837f701e_5421681579.pdf

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Afforestation strategy of the Belgrade area, Serbia (2009).

Publications

Major topics include urban forestry; climate change; green spaces and human health, social aspects, food security, sustainability; NBS for disaster risk reduction.

10. Italy

Official documents and reports

Milan

Regional Ecological Network (RER). This major planning instrument governs the territorial planning system of the Lombardy region, from regional to provincial, municipal to urban scale in a nested manner. It is based on the concept of multi-functionality and one of its main objectives, besides preserving biodiversity, is to provide ecosystem services in full compliance with the objectives expressed by the European Strategy for Biodiversity. It also aims to safeguard citizens from pollution by implementing NBS that serve as a microclimatic buffer and, in general, environmental components to protect from the hazardous fluxes of substances between the cities and outlying landscape. According to the RER, implementation of ecological networks is based on monitoring; priority indicators are used in monitoring the processes of strategic plans and projects. In this perspective, it makes reference to a strategic framework for environmental sustainability.

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Link:

<https://www.regione.lombardia.it/wps/portal/istituzionale/HP/DettaglioRedazionale/servizi-e-informazioni/Enti-e-Operatori/ambiente-ed-energia/Parchi-e-aree-protette/biodiversita-e-reti-ecologiche/rete-ecologica-regionale/rete-ecologica-regionale>

Links to PNM and the Lombardy region/other planning instruments:

<https://parconord.milano.it>; <http://www.parks.it/parco.nord.milano/Eser.php>;

<https://parconord.milano.it/come-funziona-il-parco/lente-parco/#> (Accessed 14 November 2020);

http://www.reti.regione.lombardia.it/cs/Satellite?c=Page&childpagename=DG_Reti%2FDGLayout&cid=1213602060172&p=1213602060172&pagename=DG_RSSWrapper;

http://www.provincia.milano.it/agricoltura/foreste_territorio/Piano_indirizzo_forestale

Conference proceedings

Conference entitled: “The Council relaunches three proposals of the Participatory Budget of the Municipality of Milan”. The Council of Parco Nord Milano launched an appeal to all association members to vote on implementing three projects: i) safe pedestrian mobility, ii) development of a system of green areas located west of PNM through a green arch, and iii) a bike path on the Ghisolfa bridge. The participatory budget made available for the winning project is a process through which the Municipality of Milan finances proposed projects that are developed and voted on by citizens. Link: <https://parconord.milano.it/la-consulta-rilancia-tre-proposte-del-bilancio-partecipativo-del-comune-di-milano>. Other conference proceedings may be found at: <https://parconord.milano.it/news-dalla-consulta>

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PNM Council of Associations' launch for an NBS project (2009).

Publications

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Sanesi G., Laforteza, R., Marziliano, P.A., Ragazzi, A., Mariani, L., 2007. Assessing the current status of urban forest resources in the context of Parco Nord, Milan, Italy. Land. Ecol. Eng. 3: 187-198.

Bari

Municipal Regulation of Urban Green: Provisions for the protection of urban green areas. The goal of the document is to regulate the design, construction, maintenance and use of urban green in the city of Bari. It is aimed at citizens as well as non-resident populations, the Municipal Administration Offices, public and private bodies, associations and companies in the municipal area. This Regulation determines not only the rules of use and good practices for the management of urban green spaces but also the principles, procedures and technical standards to comply with in drafting projects, specifications, and related plans. The implementation, governance and management of urban green areas regard: parks and gardens; historic gardens; green traffic islands, flowerbeds and tree hollows; green spaces belonging to municipal property; trees of particular value; publicly owned spaces destined for green areas entrusted to associations, organisations or private citizens for social use; urban gardens; the use and enjoyment of green spaces; the involvement of citizens for promoting green culture, the assignment and sponsorship of green spaces for their management and maintenance; activities prohibited in the use of green spaces; and, in any case, all green areas owned by the municipality. Link: <https://www.comune.bari.it/-/regolamento-comunale-del-verde-urbano>



Municipal Regulation of Urban Green, Bari (2020).

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Preliminary Planning Document (DPP). The DPP is the Municipality's document that provides the procedures for public-private partnerships aimed at creating primary and secondary urbanisation infrastructures and private buildings (e.g., residential, commercial, productive), as well as the services necessary for adequate urban, environmental and quality of life for its citizens. It constitutes a municipal tool that puts forth the guidelines for rebalancing the urban development of the city to improve its urban and environmental quality. The fundamental and specific objectives of the document are safeguarding environmental and historical values; verifying environmental sustainability; resolving environmental emergencies and remediating polluted sites; correcting the imbalances in the city and in the metropolitan area through by improving the quality of services and infrastructural mobility networks; developing housing policies oriented towards urban regeneration and the creation of social housing for new and less protected families. These are accomplished through the principles of sustainability, quality, efficiency, aesthetic quality of the territory, transparency, participation and fairness, flexibility, co-planning and inter-institutional collaboration.

Link: <https://www.comune.bari.it/web/edilizia-e-territorio/documento-programmatico-preliminare-dpp>

Final Report Summary - GREEN SURGE (Green Infrastructure and Urban Biodiversity for Sustainable Urban Development and the Green Economy) (EU 7th framework programme, 2013-2017). The overall project objectives were to identify, develop and test ways of linking green spaces, biodiversity, people and the green economy to meet the major urban challenges related to land use conflicts, climate change adaptation, demographic changes, and human health and wellbeing. The project provided a sound evidence base for Urban Green Infrastructure planning and implementation, exploring the potential for innovation in better linking environmental, social and economic ecosystem services with local communities. The project adopted a 3-tier approach: Tier 1 – comparative analysis of European cities/city regions; Tier 2 - Good practices (8-10 cases for in-depth study); and Tier 3 - Urban Learning Labs (ULLs) in Bari, Berlin, Edinburgh, Ljubljana and Malmö. Hence, the city of Bari was to represent the shared learning and multi-stakeholder involvement in urban green infrastructure planning in a country of the Mediterranean basin.

Through a transdisciplinary learning approach applied at the interfaces between biodiversity, biocultural diversity, ecosystem services, green economy and urban green infrastructure, GREEN SURGE developed tools, learning modules, strategies, guidelines and recommendations that are useful at the local and city-regional level to assess and react to the effects of urbanisation and environmental change. All these outputs are intended to result in impacts on urban green infrastructures in all European cities resulting in better harvesting of the multiple benefits and services from urban green infrastructure leading to multiple positive socio-economic impacts such as improved public health, climate adaptation, social cohesion, and a green economy. This work has also resulted in putting a European UGI approach to the forefront of global GI research, thereby inspiring an urban green infrastructure focus in cities outside Europe. Links: <https://ign.ku.dk/english/green-surge>; www.greensurge.eu; <https://cordis.europa.eu/project/id/603567/reporting/it>

Publications

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Smith, M., Van der Jagt, A., Ambrose-Oji, B., 2015. Local learning alliances established in five urban learning labs. Technical Report (Deliverable 7.1). GREEN SURGE Project, pp. 1-36. Available at: file:///Users/mac/Downloads/D7_1_GREENSURGE_revised_v2.pdf

Davies, C., Hansen, R., Rall, E., Pauleit, S., Laforteza, R., et al., 2015. *Green infrastructure planning and implementation: The status of European green space planning and implementation based on an analysis of selected European city-regions*. Report 5.1 GREEN SURGE Project, pp. 134. Available at: https://ign.ku.dk/english/green-surge/rapporter/D5_1_Green_Infrastructure_Planning_and_Implementation1.pdf [Accessed 15 November 2020].

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Turin

The *1995 General Masterplan* shows the city's the need to develop a sustainable approach to land and increase the green spaces around the city. More than 600 ha of formerly industrial land were designated for green and mixed-use development, with 400 ha declared green areas applying a PPP approach. The city implemented many projects: riverbank parks, connecting green areas to urban farming where animal grazing results in savings in park maintenance, and projects directed at citizen engagement through the design and creation of public parks and playgrounds.

In 2015, Turin published its third strategic plan *Metropolitan Turin 2025*. Metropolitan Turin's action plan envisions UF-NBS promoting greater physical connectivity and attractiveness in formerly peripheral or suburban areas. Therefore, 15 place-making projects are to be implemented in the broader metropolitan area to create high-quality public spaces. The projects will focus on increasing the quality of urban design and street furnishing, mixed uses in public areas, minimising the impact of poorly integrated infrastructure, improving and activating underutilised green areas, promoting bicycle and pedestrian friendly environments, and introducing innovative community management and maintenance models.

The Piedmont Region's '*Green Crown*' programme has proven to be an extraordinary tool for increasing the quality of green infrastructure within the metropolitan area. The scope of the programme will be expanded to ensure even greater coordination in: management and maintenance of green areas, promotion and communication, awareness raising and education, implementation of public health initiatives, and broadening partnerships with the private-sector and non-profit organisations. The initiative requires increased involvement of municipal councils and of the Metropolitan City authority. Link: http://www.torinostrategica.it/wp-content/uploads/2015/04/Metropolitan_Turin_2025_Summary_web.pdf

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Metropolitan Turin 2025'. Third strategic plan of the metropolitan area of Turin.

Guidelines for urban green management and first indications for sustainable planning. This document is the result of a coordinated effort among competent national authorities for the wider application of Law 10/2013 "Rules for the development of urban green spaces " for public parks. Among the essential measures for greener cities, the Guidelines indicate merging the green census, the territorial information system, the regulation of greenery, and strategic planning tools (e.g., municipal green space plan) into a general vision of public green space planning, with a view to environmental and economic sustainability. Training operators, communication, and the active involvement of citizens are also important in the shared management and enhancement of green spaces. The Guidelines are not rigid, but rather represent a consultation and information tool for all Italian municipalities, large and small, engaging in urban green space planning and management. Link: http://www.comune.torino.it/verdepubblico/patrimonioverde/documenti_materiali/normativa.shtm

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Battisti, L., Pomatto, E., Larcher, F., 2020. Assessment and mapping green areas ecosystem services and socio-demographic characteristics in Turin neighborhoods (Italy). *Forests*. 11, 25. Doi: doi:10.3390/f11010025

European Commission, (n.d.). A make-over for Turin's urban spaces. Available at: https://ec.europa.eu/regional_policy/en/newsroom/news/2016/03/23-03-2016-a-make-over-for-turin-s-urban-spaces

11. Poland

Official documents and reports

The study of determinants and directions of spatial development (Masterplan), Łódź, Municipal Planning Office.

Preparation of the Feasibility Study for the Organization of Expo Horticultural 2024 in Łódź, Ref. No: DOA-ZP-III.271.67.2018

Resolution on ensuring the proper implementation of the Project entitled "Organization of the exhibition Expo Horticultural 2024 Łódź Poland", Ref. No: 9602/VII/18

Logistics services for study visits abroad and in Poland carried out in 2020, in preparation for the organization of the Expo Horticultural 2024 exhibition in Łódź, Ref. No: DOA-ZP-II.271.22.2020

The '2022 European Green Capital Award': overview of the city of Krakow; Portraits of Krakow based on indicators: Nature and Biodiversity, Air quality, Green growth and eco-innovation, Governance, and Sustainable land use; a case study.

The City Greenery Board of Krakow, established in 2015 under a Resolution of the City Council, the management, maintenance, construction and revitalisation of urban greenery in Krakow. Among its numerous activities are: the development of a system of green areas, programmes for nature protection, and improvement of aesthetics and recreation in accordance with the guidelines of the organisational unit of Krakow City Hall, competent in matters of landscape architecture and policy regarding green areas. The Board also obtains external funds for shaping and developing the green system in the municipality of Krakow and for raising environmental awareness, promoting green areas and activating the Krakow community.

The Board is currently drafting the document *Directions for the development and management of green areas in Krakow for 2017-2030* report. The document will contain comprehensive guidelines for the maintenance and development of green spaces, which will form the basis for planning and implementing the tasks of the Municipal Greenery Board and a guarantee of the implementation of a coherent long-term policy for the development and management of green spaces in Krakow. (Link: <https://zsm.krakow.pl>)

Development Strategy for the City of Poznań 2030. The primary goal of the city strategy is to improve the quality of life for all inhabitants. One of the five strategic objectives is to build 'A

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green, mobile city', which sets out NBS objectives, while the other strategic objectives, including 'Friendly housing estates' and 'The spirit of community and social dialogue' contain NBS elements. NBS objectives are also incorporated in the documents on strategy and additional spatial planning – *Development Strategy for the River Warta in Poznań 2012–2030* and *Environmental Protection Programme for Poznań 2013-2016* for 2020 – with the aim of revitalising and protecting the green wedge areas along the Warta, Cybina and Bogdanka rivers. These objectives are intended to protect the green areas from new developments, preserve existing parks and create new ones and recreational areas. The *Development Strategy for the River Warta in Poznań 2012–2030* aims to create extra space for the river Warta, deepen the Bogdanka riverbed, build additional river channels and increase recreational activities on the rivers. NBS are recognised as tools for contributing towards social objectives in all strategic city documents, i.e., developing environmental education, supporting and creating new open public spaces, making the city family- and senior citizen-friendly, supporting cultural and sporting activities for social development and improving the health of residents.



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The Expo website: expo2024.uml.lodz.pl

The City Hall of Łódź: <https://uml.lodz.pl/aktualnosci/arttykul/expo-2024-w-lodzi-zobacz-wyniki-konsultacji-eksperckich-id28682/2019/6/19/>

Municipal Planning Office – local zoning plans – numbers 19, 117, 121, 129 (3rd May Park, Tuwima, Małachowskiego, Konstytucyjna, Kopcińskiego and Przędzalniana Streets).

PwC company: <https://www.pwc.pl/pl/media/2018/2018-12-14-expo-horticultural-2024-lodz-pwc.html>

Local association created to express opposition to the Expo: <http://niedlazielonogoexpo.pl/>

AIPH website: http://aiph.org/aiph_event/nature-of-the-city-lodz-poland-a1/

Article in the local press: <https://dzienniklodzki.pl/apartamenty-tuwima-osiedle-obok-parku-3-maja-w-lodzi-apartamenty-tuwima-plany-budowy-tysiaca-mieszkan-w-lodzi/ar/c9-14745928>

Article in the local press: <https://lodz.wyborcza.pl/lodz/7,35136,24931713,zielonego-expo-w-lodzi-nie-bedzie-glinski-trzeciorzedna.html>

Article in the local press: <https://lodz.wyborcza.pl/lodz/7,35136,24934850,rzad-pis-nie-da-lodzi-zielonego-expo-wiceprezydent-gdy.html?disableRedirects=true>

Article in the local press: <https://lodz.wyborcza.pl/lodz/7,35136,25173300,lodz-szykuje-sie-do-zielonego-expo-o-wystawie-wiadomo-coraz.html>

Interview with Maciej Riemer (on Radio Łódź): <https://www.radiolodz.pl/posts/42376-maciej-riemer-radio-lodz>

12. Finland

Official documents and reports

Strategies and programmes

Sustainable city is a programme coordinated by the Ministry of the Environment involving 16 cities in Finland. The programme promotes the sustainable development of cities and municipalities through practical urban development and strategic management. The main themes of the programme are carbon reduction, smart solutions, health aspects and social development. The programme seeks solutions to the challenges that connect these themes and fill in the gaps between them. One important example of UF-NBS in this programme is the aim for healthy cities to have good air quality and minimal noise pollution and also the aim to engage in recreational activities. Green areas and structures also improve the ability of cities to adapt to growing challenges posed by climate change, such as floods, heatwaves and declining biodiversity. The programme aims to create new partnerships and promote cross-sectoral collaboration, develops new, tested sustainable urban development solutions, produces

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innovators at the national level, generate new business opportunities, and establishes an operating model for broader implementation of good practices. The five-year programme will be implemented in 2019–2023. The programme is in cooperation with cities, municipalities, several other ministries and operators working towards sustainable urban development. Link: <https://www.kestavakaupunki.fi/en-US>

Forest Biodiversity Programme for Southern Finland (METSO). Voluntary forest protection by landowners is very important in southern Finland where the network of national parks and other nature reserves is not well developed. Voluntary forest protection is promoted by the State through the Forest Biodiversity Programme for Southern Finland METSO 2014–2025. The METSO Programme aims to halt the ongoing decline in the biodiversity of forest habitats and species, and establish stable favourable trends in Southern Finland’s forest ecosystems. It is a collaborative effort between the Ministry of the Environment, the Ministry of Agriculture and Forestry and different stakeholders. Based on the results of a survey conducted in 2015, the report describes the implementation of the METSO Programme and, more generally, the protection of forest diversity in municipalities. The report examines the awareness of the METSO Programme in the municipalities and finds out what kind of information needs the municipalities have towards the METSO Programme. The survey was targeted at municipal forest officials and was answered by 79 municipalities across Finland.

Based on the survey, municipalities have actively participated in the METSO Programme, and there seems to be an interest in municipalities to safeguard forest diversity. Forty per cent of the municipalities had protected sites eligible for the METSO Programme as private protected areas and sold or exchanged land to the state for nature conservation purposes. In addition, sites identified as valuable in nature had been excluded from forestry activities or taken into account in land use planning or secured by other means. When protecting the forest in METSO Programme, also the municipalities are allowed for reimbursement. Link: https://jukuri.luke.fi/bitstream/handle/10024/545238/luke_luobio_90_2019.pdf?sequence=1&isAllowed=y

Drainage and storm water programme of city of Helsinki. Storm water is rainwater and melted snow that runs off streets, lawns, roofs and other sites and surfaces. Drainage and storm waters are increasingly being utilized as nature-based solution with a target of comfortable, high-quality and sustainable urban space. Terrestrial stormwater constructions, such as floodplains, rain-gardens and other water issues, enrich for example the parks and streets and the living environment of inhabitants and other urban dwellers. When possible, the stormwater and vegetation are being connected together.

Storm water reflects human activity, which distinguishes it from other run-off water. The storm water programme presents the City of Helsinki's own measures for the development of comprehensive storm water management in a planned, sustainable and in a long-term manner. The storm water programme specifies the objectives and measures of the storm water strategy and takes into account the development and changes in the urban environment. Link: <https://www.hel.fi/static/liitteet/kaupunkiymparisto/julkaisut/julkaisut/julkaisu-03-18.pdf>

Publications

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Topics: 1) Nature/Urban green and human health and wellbeing; 2) Participatory planning and management of urban green; 3) Research on nature/urban forests and human health; mobility, disability and green spaces; environmental factors associated with green exercise in urban and suburban areas; forest biodiversity programme; preserving the forest nature in municipalities; prevention and control of floods; urban runoff programme of City of Helsinki; and urban tree policy.

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13. CHINA - Beijing

Official documents and reports

Urban and Rural Planning Law of the People's Republic of China

Forestry Law of the People's Republic of China

Beijing's overall planning (2004-2020)

Beijing Greenspace system Planning (2007-2020)

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15. CHINA – Meishan

Official documents and reports

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Urban green space planning system of Meishan City (2011-2020)

Regulatory detailed planning of Dongpo island of Meishan City (2010-2020)

16. CHINA – Jiaxing

Official documents and reports

Urban and Rural Planning Law of the People's Republic of China

Urban green space system planning of Jiaxing (2006-2020; Revision 2016) (in Chinese)

Urban Master Planning of Jiaxing (2003-2020; Revision 2017) (in Chinese)

Master Planning of National Forest City Construction in Jiaxing (2018-2035) (in Chinese)

17. CHINA – Yiwu

Official documents and reports

Urban and Rural Planning Law of the People's Republic of China

Forestry Law of the People's Republic of China

Master plan of Yiwu City (2013-2030)

Plan for Yiwu New town based on the high-speed train system (2017-2035)

Master plan of Yiwu Information Photoelectric High-tech Zone (2017-2035)

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18. CHINA – Qingdao

Official documents and reports

Urban and Rural Planning Law of the People's Republic of China

Forestry Law of the People's Republic of China

Qingdao Greenspace system Planning

Qingdao's overall planning and guidelines of the Fushan Eco-Park

APPENDIX 2: CASE HISTORY GLOSSARY OF TERMS

Economic framework:	Economic frameworks refer to the different economic aspects related to the functioning of UF-NBS, primarily as funding mechanisms and sources, economic benefits and costs including broad economic issues such as local branding and related business opportunities and economic models. Among other things we wish to investigate how UF-NBS has been integrated into real economies (adapted from GREENSURGE D4.1; Andersson et al., 2015).
Ecosystem services:	The benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as



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	soil formation, photosynthesis, and nutrient cycling. (Source: MEA, 2005).
Financing of UF-NBS:	The provision of funding for UF-NBS using different mechanisms and financial instruments, e.g., public sector grant, private sector capital investment, use of trust funds held by charity (also see Procurement of UF-NBS).
Governance arrangement:	The process by which plans are implemented is linked to governance, since plan implementation involves many actors across all sectors including for example, NGOs, community groups and many departments of municipalities.
Institutional framework:	The formal and informal rules of a governance system that shape human choices, behaviours and interactions (source: Biernacka & Kronenberg, 2018). Specifically, it involves organisations (governance actors), laws and regulations. Governance actors extend beyond the public sector and include companies (businesses large and small), charities and NGOs.
Integration:	The practice of urban forestry is the planning and management of all the trees in and near urban areas; individually, in groups or in recognisable woodlands and forests. Trees in any of these settings do not exist in isolation from adjacent land uses and other infrastructures. The integration of trees with other land uses and infrastructures is key to the successful delivery of the ecosystem services they can provide. Hence, with regards to UF-NBS, integration should involve UF-NBS typologies along with others that are non-UF-NBS such as built-up structures (through sustainable urban designs), transport infrastructure, and water management system amongst others.
Inter, cross and transdisciplinary:	<p>An inter-disciplinary approach in UF-NBS integrates knowledge and demands from different disciplines, such as landscape ecology, urban and regional planning and landscape architecture.</p> <p>The cross-dictionary approach in UF-NBS means that individual researchers in urban forestry should view the needs of other discipline in their research. For example, a researcher looking at the contribution of urban trees air quality should also be considering how their work addresses the needs of public health scientists, who are considering the impact of urban air quality on, for example, on clusters of diseases in neighbourhoods.</p>



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	<p>A transdisciplinary approach in UF-NBS means that different research disciplines should collaborate, normally in advance, to agree shared frameworks, methodologies and research questions on the principle that each researcher contributes equally to the research being undertaken. A key benefit of this approach is to widen the opportunities for peer-review publishing and wider dissemination.</p> <p>All of these approaches share an aim to interlink disciplines, between science, policy and practice. In CLEARING HOUSE we anticipate this being developed in partnerships between the research community with different local authorities and other stakeholders in the private and third sectors.</p>
Multi-scale:	Urban forestry planning should be considered at different spatial levels ranging from city-regions to local projects.
Multifunctionality:	Urban forests provide several ecological, socio-cultural, and economic benefits concurrently. Urban forestry planning aims at intertwining or combining different functions to enhance the capacity of urban green space to deliver valuable goods and services.
Network/Connectivity:	An aim for urban forestry is to seek added values derived from interlinking green spaces with urban forests in a functional and physical way.
Procurement of UF-NBS:	The means by which Urban Forest goods or services are purchased or secured.
Renaturing:	Creation of new natural spaces such as green roofs, areas, or habitats; transformation of grey infrastructures into green spaces (Sources: Davis, M. et al., 2018; European Commission, 2015).
Sino/European comparative relevance:	Specifically UF-NBS which show notable similarities or differences between the two continental situations, e.g. a similarity would be the management of trees in an urban park and a difference would be the scale of projects which are often much larger in China.
Social cohesion and biocultural diversity:	<p>The capacity of a society to ensure the welfare of all its members, minimising disparities and avoiding polarisation. People from different backgrounds have an equal chance to participate in decision-making, have similar life opportunities and equal access to services, including, access to urban forests.</p> <p>Biocultural diversity consists of biological diversity at all its levels, from genes to populations to species to</p>



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	<p>ecosystems and cultural diversity in all its manifestations (including linguistic diversity), ranging from individual ideas to entire cultures and the interactions among all of these. (Source: Loh & Harmon, 2005)</p>
<p>Strategic planning processes:</p>	<p>Planning processes based on long-term spatial visions supplemented by actions and means for implementation but that remain flexible over time. The strategic planning processes are usually led by the public sector, but that does not mean that non-state actors are excluded.</p>
<p>UF-NBS typology:</p>	<p>Allied to all NBS, UF-NBS are actions involving trees, woodland and associated green infrastructure which are inspired by, supported by or copied from nature, and simultaneously provide environmental, social and economic benefits.</p> <ul style="list-style-type: none"> • Forested areas, remnant forests, forested nature reserves, riparian forests; • Forest plantations; • Community parks, green urban areas, pocket parks, historical gardens or country parks with trees (i.e., large urban public park, amenity green spaces, LAPs (local areas for play), LEAPs (locally equipped areas for play) and NEAPs (neighbourhood equipped areas for play)); • Woodland play area; • Tree rows, e.g., promenades or boulevards, street trees, street greenbelts or green verges with trees; • Hedgerows, including hedgerows with standard trees; • Wooded railway banks; • Woodland glade or species-rich meadow influenced by adjacent trees; • Wooded or shrubby foraging area for wild berries, fruits and fungi; • Wooded riverbank green and wooded banks of ponds and lakes; • Ornamental trees; • Survivor trees; • Veteran trees; • Rain gardens with trees; • Allotments, house gardens, courtyards, or urban gardens with trees;



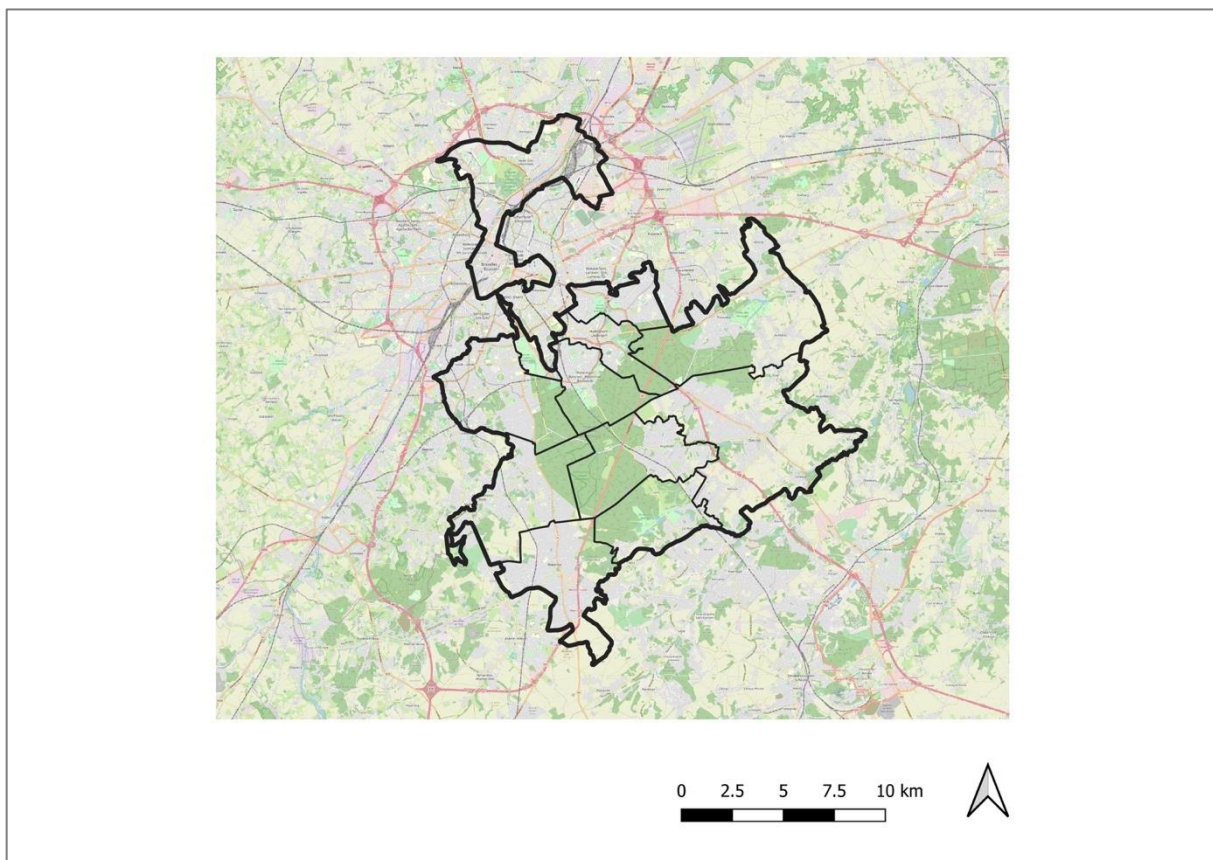
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	<ul style="list-style-type: none"> • Botanical gardens; • Arboretum; • Feng shui garden; • Wooded cemeteries and churchyards; • Fruit orchards; • Bioswales with trees, tree trenches; • Wooded greenways and trails.
<p>UF-NBS valorisation:</p>	<p>Valorisation is the process of creating value from knowledge by making knowledge suitable and/or available for economic and/or societal use and translating that knowledge into competitive products, services, processes and entrepreneurial activity (Source: The Netherlands Government, 2009). Hence, UF-NBS valorisation can be considered as the process of creating value from urban forest interventions.</p>

APPENDIX 3: PROFILES OF CLEARING HOUSE LOCALITIES

Appendix 3 consists of summary profiles of the localities that are under scrutiny in the CLEARING HOUSE project. The profiles were developed as part of WP2 and each one includes elements of general context, information on the current state of UF-NBS in the locality, an analysis of UF-NBS governance and lastly an outlook on the strategic objectives for the locality and on the existing challenges and barriers.

The Sonian City, Belgium – Brussels and neighbouring areas



The Sonian City is the area including and surrounding the Sonian Forest in Belgium. It is located at the south-eastern periphery of the country's capital city, Brussels, and its territory spans across three regions (the Brussels Capital Region, Flanders, and Wallonia). While the Sonian Forest (FR Forêt de Soignes, NL Zoniënwoud) is a widely studied forest with defined boundaries, the Sonian City is an operational concept to be developed and researched within the CLEARING HOUSE project. It consists of the Sonian Forest at its core (i.e., 4,383 hectares of non-urbanised land, protected by several decrees as Natura 2000, Forest and natural reserve and regional planning tools) and the neighbouring areas where the forest ecosystem stretches toward and intertwines with the urban areas.

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State of the Urban Forest. Understanding the state of the urban forest in the area requires a combined analysis of both the state of the forest and of the city. The forest ecosystem is dominated by beechwood (“Kathedraal beukenhout - Hêtraie cathédrale - Beechwood Cathedral”), hosting an exceptional fauna and flora. Since the largest part of the forest has never been cleared, it has preserved a relief and soils that have not been modified by agriculture for more than 10,000 years. The Sonian Forest is characterised by micro and macro ecosystemic linkages whose continuity is strongly influenced by the surrounding developed land. An in-depth study of the ecological structure of the forest has brought to light the main threats to the forest, which include the mobility infrastructure which cuts through the forest breaking its ecological structure, and the recreative pressure.

The embeddedness of the Sonian Forest in the urban fabric implies that it is not sufficient to understand how urbanisation represents a pressure on the forest but rather how the forest stretches into the city: in this context, virtually all urban trees and urban green spaces (and not only the remnants of the millenary forest) become dots to be linked to draw a picture of the Sonian City. Research based on remote sensing shows that vegetation covers 54% of the regional territory, making Brussels a rather green city. At the same time, important inequalities are present throughout the regional territory: this number drops to 30% in the first belt (première couronne), and even to 10% in the city centre. In addition, it should be noted that a large share of these green areas is inaccessible to the public (private gardens or estates, spaces associated with roads, railway embankments, housing complexes, etc.). A 2009 inventory calculates that only 19% of the regional territory could be considered as public green space, which means a regional average of 28 m²/inhabitant. Crucial challenges include the provision of high-quality green space, its fair distribution throughout the territory, and its ecological connectivity.

Governance, planning, and policy landscape. The territory of the Sonian City spans different administrative boundaries. Relevant authorities include the local governments of 11 municipalities: the provincial governments of the Flemish Brabant and Walloon Brabant, and the regional governments of the Brussels Capital Region, Flanders and Wallonia. The federal government and the Language Communities have certain competences in this territory but only play a rather indirect role. This administrative fragmentation implies that the planning approach is not uniform throughout the territory but follows the borders of the three regions, resulting in three separate planning frameworks.

As far as the core area is concerned, one of the most important policy instruments is the "Natura 2000" network, in which the 'core' part of the forest and some neighbouring green areas are registered. This is a European network of natural or semi-natural sites important for both the fauna and flora that are present. Unlike many nature reserves, Natura 2000 areas are not "closed" reserves: human activities are still allowed as long as they do not compromise the "objectives for nature" in the areas. Building on it, every region also has a management plan for the portion of forest under their jurisdiction. To foster cooperation between the different regions, the Structural plan for the Sonian Forest was drawn up and a platform of permanent cooperation was established in the form of the Sonian Forest Foundation. For the city/forest areas surrounding this forest core, the landscape of policies and regulations impacting UF-NBS is much more fragmented. Some provisions are included in more general policy and planning tools (i.e., not immediately targeting the environment), at the regional, provincial and communal levels. There are also some policy tools targeting environmental issues.

Citizen science participation & contestation. Albeit not new, the concept of participatory governance, as an institutionalised process of citizen involvement in policy making is in its infancy. While different policies on the environment and support for citizen initiatives have been developed, these seem to be still at the trial-and-error stage in terms of how they interact and collaborate with new forms of citizen engagement. Today, it is mainly at the communal level that new forms of participatory governance take place, with many communes having a deputy mayor charged with participation and different initiatives. In relation to UF-NBS, a number of projects are worth attention, such as the "Renforcement du Réseau Ecologique Bruxellois", which includes efforts to define nature development strategies of selected neighbourhoods via participatory processes. Citizen science, as a specific form of participation, is becoming increasingly popular. In the last years a wealth of projects have been initiated – or supported – by public authorities, e.g. the portal observations.be, which allows citizens to encode observations about local flora and fauna, or the Wood Wide Web, consisting of a crowdsourced cross-media inventory of remarkable trees across the regional territory. In addition to "projects" and institutionally backed activities to enhance ecological connectivity, in the area there are numerous cases where citizens have also mobilised to protect tree ecosystems in Brussels from land speculations and urban development plans. And this was also in conflict with the authorities.

Socio-economic trends. The Sonian City and Sonian Forest are located in the south-eastern part of a metropolitan area of about 2.5 - 3 million inhabitants, gravitating around Brussels. The morphology of the agglomeration is determined by the historical development which proceeds in concentric circles, from Brussels city centre to the first and second ring roads and then to the suburbs, characterised by urbanisation around small, closely spaced cores. From a social, demographic and economic perspective, the area is characterised by a strong duality between the urban core and the periphery, which again follows different paths in the Flemish and Walloon parts of the zone. In terms of population density, the centre of gravity of the metropolitan areas is located in the very heart of Brussels. High values are also achieved in areas of secondary cities. Overall, the densities are lower in Wallonia as opposed to the Flemish part of the area characterised by scattered housing. The same duality is observed in socio-economic terms. Brussels Capital region presents an average income that is lower than in the other regions (14.372 EUR per capita vs. 18.331 EUR at the national level), and almost a third of the residents live below the at-risk-of-poverty line. The rest of the metropolitan area scores better than the Belgian average, with the provinces of Flemish Brabant and of Wallon Brabant presenting the highest average income in the country (21.963 and 21.576 EUR per person, respectively). The area around the Sonian Forest stands out on the map as one of the most affluent of the area. The population is highly qualified with a very high average taxable income, the housing market is the most expensive, there is little unemployment and a small share of blue-collar workers.

Major challenges & knowledge gaps. One of the biggest problems for the enhancement and maintenance of the urban forest and its ecological connectivity is the virtually ongoing land development, which reduces the sheer number of green areas of all kinds, but also inasmuch as it is done with little consideration of the translocal ecological landscape, critically hampering ecological connectivity. A crucial dilemma is sometimes referred to: whether it is preferable to densify the urban core, thereby reducing green spaces and connectivity which is already scarce,

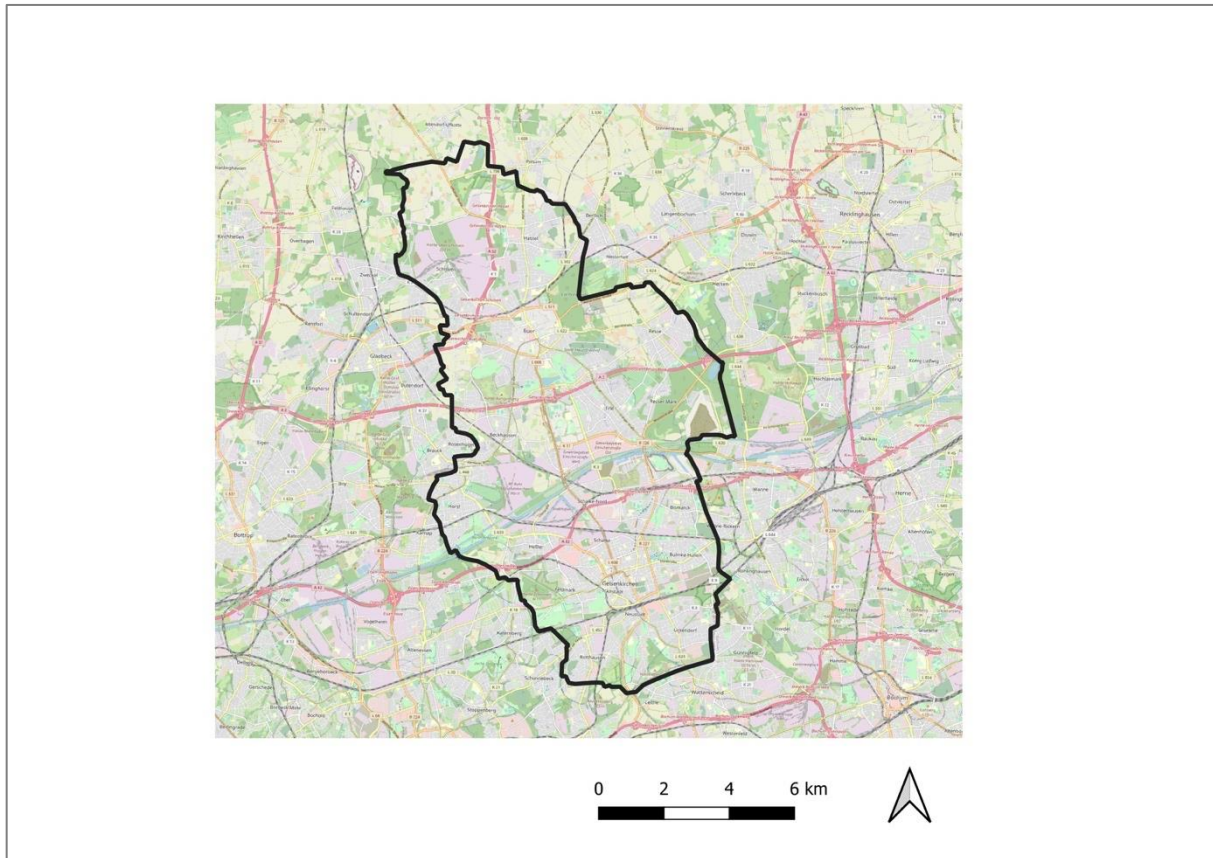
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or the periphery encroaching on existing open spaces and natural areas. The latter is a particularly relevant challenge at the edges of the Sonian Forest, where return to land development can be extremely high. Another important question, however, precedes this dilemma, and concerns whether urban development is necessary at all considering the current demographic trends and the fact that all too often opportunities are missed in terms of "re-greening" large quasi-public spaces (e.g., squares, sport facilities). A critical component of urbanisation-related challenges to ecological connectivity concerns the development of mobility infrastructures. Roads (and to a lesser extent railroads) represent a source of fragmentation and destruction of tree ecosystems, especially but not only in the core part of the forest.

Overall, the current legislation seems to be insufficient to protect, and in any case, to foster ecological connectivity because of a virtual absence of juridical value for the regional ecological network. Existing urban planning regulations are often breached, also because of scarce monitoring efforts, derogated on, and modified to allow new developments. There is virtually no regulation to preserve greenfields, with the only one concerning the preservation of large ponds. The governance and management issues concerning existing tree spaces in the city are related to the maintenance costs of trees on public land, but also the training of staff, which pays little (or no) attention to biodiversity and eco-connectivity questions. Often the necessary expertise is simply missing at the relevant decision-making level. In addition, the sound governance of a complex and articulated field such as the protection and enhancement of ecological connectivity is also hampered by institutional fragmentation and the lack of cooperation between different levels of governance and policy sectors.

Lack of knowledge about UF-NBS does not seem to be a challenge as such. Consultations among local stakeholders shed light on a rather widespread consensus that already a lot of knowledge is available for the area, and that emphasis should be placed on identifying venues for translating that knowledge into policy action (e.g., knowledge-based policy tools, inventories of relevant academic literature, inventories of existing laws and regulations, methods for effective awareness raising) and to bridge the gap between expertise on urban planning and biodiversity conservation expertise. An interesting aspect concerns the cartography of the area. Institutional fragmentation implies that most maps are limited by regional boundaries, making it difficult to frame and even to conceive the Sonian City as a geographic entity, and thus as an object of policy intervention. In this context, designing maps and conducting geographic analysis that deconstructs and reconstructs ecosystemic, functional and administrative boundaries can be helpful to "think" the Sonian City, activate the existing knowledge, and then to devise adequate interventions.

City of Gelsenkirchen, Germany – In the middle of the Ruhr metropolis



Gelsenkirchen is located in North Rhine-Westphalia (NRW) in the middle of the largest polycentric conurbation in Germany, the Ruhr metropolis (Ruhr area) counting over 5 million inhabitants, and has 264,710 inhabitants (September 25, 2020). Around 31% of the people living in Gelsenkirchen are German citizens with a migration background and/or foreign citizens.

As a result of decades of economic and social change (Gelsenkirchen was previously characterized by the coal and steel industry – the ‘City of a Thousand Fires’), the city has now renovated and rebuilt numerous former mining sites (coal mines, coking plants, steel works) and given them new uses. Some of these fallow areas have been converted into smaller inner-city parks or integrated into urban and regional green and forest areas ("Emscher Landscape Park" of the Ruhr Metropolis) and fulfil functions as "urban wilderness areas", "nature discovery areas", and "places for extracurricular learning" ("Biomass Park, Rheinelbe Forest Station") as well as "Green Laboratories" with a focus on nature experience, community gardening, urban forest and (environmental) education.

State of the Urban Forest

The Ruhr area is shaped and reshaped in many parts by anthropogenic influences. Therefore, depending on their origin, the forest images range from old forest relics with remnants of potentially natural vegetation to planted forests to pioneer forests on post-industrial areas that

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have emerged from succession. They form a significant part of the green infrastructure in the Ruhr area. The socio-economic and ecological services of the forest represent an irreplaceable social value. Here, regulatory ecosystem services (CO₂ sink function, fresh air formation, fine dust filtering, flood protection, cooling effect) of the forests are just as important as their function as an important recreational area. At the same time, the biodiversity of these forests is impaired by heavy pollution, eutrophication and a high level of disturbance, which contribute to a certain homogenisation of flora and fauna and the promotion of neobiota. Forests in the territory of the Ruhr Regional Forestry Office: 70,000 ha (total area: 340,000 ha); Share of forest cover: 21% (NRW 27%); Forest area per inhabitant: 143 m² (NRW 508 m²); Distribution of ownership: 67% private forests, 32% communal/state forest. In Gelsenkirchen there are around 1,430 hectares of land with a forest-like character (total area of the city: 10,494 hectares) - of these 100 hectares are forest in parks and 270 hectares of industrial forest and forest areas on slagheaps.

Industrial nature or the industrial forest is a specialty in the Ruhr area. The term industrial nature refers to nature that has developed independently on the areas of the former mining industry, on derelict railway tracks, train stations and commercial areas. Industrial nature is an expression of the decline in industry and at the same time a signpost for new open spaces. As a result, a 'new type of ecosystem' has established itself which did not exist in pre-industrial nature. Large and structurally rich industrial wastelands are hot spots for biodiversity, as they are often home to many endangered animal and plant species. In addition to the ecological networking of living spaces, they make a significant contribution to urban biodiversity and are at the same time places for relaxation, nature experience and environmental education.

In the course of succession, the former open land biotopes develop into forests in the long term. As the examples of the Hugo Green Laboratory and the Rheinelbe Forest Laboratory show, the links and synergies to the subject areas of 'history', 'social' and 'environmental education' are very pronounced.

'Grünlabor Biomassepark Hugo' - a "green laboratory" and a "learning place for education for sustainable development" - and its neighbouring city quarters. (Duration: since 2016) https://www.gelsenkirchen.de/de/Infektur/Umwelt/Klima/Klimaschutz/Erneuerbare_Energien/Biomassepark_Hugo.aspx. With innovative forest types and forest combinations, answers to climate change and the energy transition in the biomass park are sought, taking into account social and nature conservation aspects. A concept was developed here with many actors in which the experience of nature, joint action and (environmental) education find a suitable place. In this way, a new city park could be won, which incurs lower maintenance costs than usual and at the same time develops new qualities through civic engagement.

'Industrial forest Ruhr area (Industriewald Ruhrgebiet)' - a learning place for education for sustainable development and succession research – forest of the future. (Duration: since 1996) <https://www.wald-und-holz.nrw.de/ueberuns/einrichtungen/regionalforstaemter/ruhrgebiet/industriewald-ruhrgebiet>. The aim of the project is to maintain the industrial wasteland of Emscher Landscape Park through natural development processes and to make it accessible to people in a targeted manner as a nature experience, nature experience spaces, places of environmental education and recreation close

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to home. The result is a completely new, authentic type of open space in the Ruhr area, which combines aspects of the past as a production location with those of the present (fallow land) and future (forest). The developments are accompanied by natural and social sciences. The change in process on the industrial wasteland is also taken up in landscape art, accentuated by design measures and taken into account in a special way. Due to the last three dry years (2018-2020), the trees in the Ruhr area suffer from the consequences of drought. In addition, there are further impairments from the ELA storm in 2014 (June) and Friederike storm in 2018 (January), ash shoot death, soot bark disease of the maple, beech complex disease as well as the small beech bark beetle and oak processionary moth, which led to a significant loss of tree vitality.

Governance, planning, and policy landscape

The Ruhr Regional Association (RVR) is the amalgamation of eleven big cities and four districts in the Ruhr Metropolis. The RVR is currently preparing a regional plan for the entire Ruhr Metropolis. It is not only responsible for state regional planning in the region, but is also responsible for important infrastructure projects such as the Route of Industrial Culture and the Emscher Landscape Park (ELP).

In Germany, municipal land-use planning is located below regional planning. As the lowest level of spatial planning, there is binding land-use planning in the form of a development plan at the district and neighbourhood level.

The city of Gelsenkirchen has had a legally binding “landscape plan” since 2000. The landscape plan implements the goals and measures of nature conservation in the area of the city. It specifies and supplements the nature conservation content of the regional plan as a landscape framework plan. The landscape plan records and evaluates the natural balance in the planning area, develops goals and measures for the sustainable protection and development of protected assets. The protected assets include plants, animals and biotopes to be preserved in their biological diversity, as well as the landscape. Soil, water, air and climate should be protected as much as possible through measures of nature conservation and landscape management.

ELP is a regional cooperation project in the northern Ruhr area to create the world's largest connected park system (450 km²). Due to the industrial and montane past of the region, the natural landscape is heavily populated, has changed many times and is structured like a mosaic. The aim of the landscape park is to create a new type of park that combines different open spaces: Preserved pre-industrial cultural landscape, areas of the regional green corridors that have been created since 1920, industrial landscape and post-industrial landscape. The more recent development of the ELP is documented in the ELP 2010 master plan, which has been drawn up by the 20 participating cities and regional institutions since 2002. It defines the area of the park and names the main themes of development (New Emschertal, ecology, infrastructure, culture, urban agriculture and forestry, development and vegetation management).

Citizen science participation

In order to meet the major global and local challenges, long-term strategies based on the principles of sustainable development are required. In recent years, Gelsenkirchen's strategy has focused on prevention, education and participation as well as the idea of a "Learning City" - the combination of integrative, equal opportunity and good education with 'Education for

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Sustainable Development (ESD)⁹. The city of Gelsenkirchen has joined the United Nations' Agenda 2030. In 2016 the City Council - as the first of a German municipality - unanimously passed the **Agenda 2030 resolution: 'Shaping sustainability at the municipal level'**. The city of Gelsenkirchen has received several awards for this.

Gelsenkirchen has been working with the dynamic '**coexistence integration concept**' since 2015, which is being further developed as required in the participatory process with citizens. Accordingly, for the multi-ethnic city of Gelsenkirchen actively shaping integration work and living together is a self-binding, permanent and future-proof task. New challenges arise, particularly in light of current backgrounds such as flight, immigration, and tendencies towards radicalization. Encounters at eye level and mutual respect are of particular relevance. In the competition entry 'City of the Future 2030+ - Learning City', Gelsenkirchen also focuses on education and participation. In addition to the concept of future education, research into Citizen Science 2.0, a further development of the well-known Citizen Science concept, which is central to the research project. Urban society, science, administration and business work together on an equal footing on the conception and implementation of concrete measures. This learning by doing process researches what is needed to enable work on equal terms at the interface between science and practice.

Socio-economic trends

As a former centre of the coal, iron and steel industry with almost 400,000 inhabitants, 14 mines and the location of the steel, glass and textile industry, the city recorded a population decline of around 150,000 in the 1970s with the decline of the mining industry. At the same time, efforts were made to find new uses for the industrial and commercial sites which had fallen into disuse as a result of structural change. The International Building Exhibition (IBA) and the 1997 Federal Horticultural Show (BUGA 97) were important impulses for a fundamental change of direction - economically, ecologically and socially.

The course was set for a move away from large industrial structures towards smaller and more flexible companies, company start-ups were promoted, as was the linking of R&D (research and development) with the economy. In the course of a changed ecological awareness, Gelsenkirchen became a 'solar city'. Green spaces, parks and forests were created at former mining and steel sites, regional green corridors were created with regional cooperation projects, and the network of cycle paths was expanded on former railway lines.

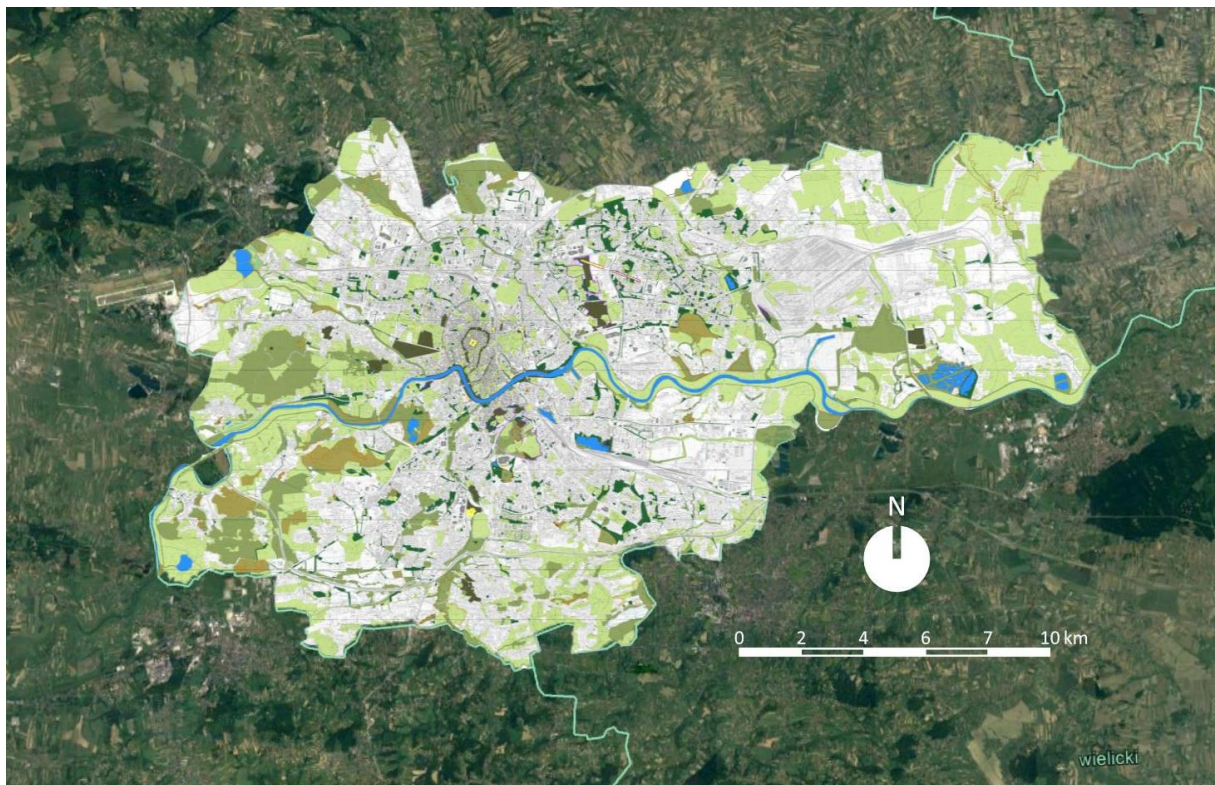
Major challenges & knowledge gaps

- Strategic conflicts in relation to land use (green areas vs. commercial and residential areas)
- UF-NBS vs. economic forest use
- The last green island locations in city districts/quarters are often built over as part of the so-called 'densification' and thus withdrawn from green use for people. The use of these open spaces for construction purposes (especially with existing tree and forest structures) results in compensation obligations, such as replacement afforestation, for which available areas must also be found.
- Nature-based solutions are not yet in the consciousness of politics and administration; technical solutions are usually the focus.

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- The funds made available are not sufficient to guarantee sustainable financing of life-cycle costs for the maintenance/upkeep of green infrastructure and UF-NBS in times of climate change. Recommendations for action for comparable cost optimisation are required.
- The monetary profit generated by UF-NBS measures in the long term or the benefits from ecosystem services (society, health, environment, economy) are not sufficiently qualified and quantified.
- Although several best practice examples already exist in Gelsenkirchen, a rollout of measures of education on UF-NBS is necessary.

Kraków, Poland



Kraków with its surroundings. City map taken from the document “Directions for the development and management of green areas in Kraków for 2017-2030” showing different categories of green areas in Kraków.

Kraków is a strong urban unit with a population of over 800k and a cultural, academic, industrial and touristic centre of national significance. It is a part of Metropolia Krakowska - an institutionalised platform of cooperation for Kraków and 14 surrounding municipalities, whose main task is to implement Integrated Territorial Investments in the Kraków Functional Area. Kraków benefits from its size, importance, its cultural, creative and social capital as well as from its natural heritage and surroundings. Among the biggest challenges are considerable air pollution, uncontrolled urban sprawl and housing development, shrinking areas of green spaces (often connected to the previous point) and touristification (slowed down by COVID-19).

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State of the Urban Forest. Green spaces and green infrastructure in Kraków were most extensively described in *“Directions for the development and management of green areas in Kraków for 2017-2030”*. City forests are mostly covered by the “Powiat Programme to Increase Afforestation in the City of Kraków for the years 2018-2040”. The first one defines the cities’ natural system as “consisting of not only arranged green spaces but also of those intended for agriculture or that remain unused - postindustrial, post-agricultural or natural and semi-natural landscapes”. It also accepts the concept of “third nature” by admitting that nature is developing in various locations - housing estates, industrial zones etc., even though the name itself is not used. It also divides cities’ green spaces into two categories - public green spaces and contributing green spaces. The first one being at least partially designed, open for inhabitants and covered in greenery by at least 50%; the second consists of other spaces, e.g. cemeteries, gardens, allotment gardens, agricultural lands. Forests can be divided into two types - regular forests and forest parks, and fall in both categories of green spaces, depending on their landscape and infrastructure.

The main urban forest areas in the city are Bielany-Tyniec Landscape Park (a large terrain of protected nature on the western part of the city borders) and smaller forests scattered around the city, e.g. Borkowski and Mogilski forest. Other vital elements of a local ecosystem are rivers (Wisła and several smaller rivers) and their waterbanks. Other significant green spaces are Planty (former fortifications surrounding the old town), Błonia (a large meadow in the centre of the city), as well as city parks and allotment gardens. There are also multiple protected areas, including the Nature 2000 programme, smaller parks and green, unused spaces, which also support the local ecosystem.

Governance, planning, and policy landscape. At the city and local level the main executive representative is the city’s president, who appoints his deputies and proxies to specific cases. One of the president’s deputies deals with sustainable development of the city. The main legislative power is the city council, which approves every decision, plan or strategy of the city. Additionally, every district (18) has its own council that supports the city level government and works on quality of life and the needs of their neighbourhood citizens. The city is further divided into faculties (27), referees and independent positions that prepare plans and programmes. Another element of the city government is management, which focuses on specific parts of the cities’ infrastructure. The one most important element considering blue-green infrastructure is *Green Spaces Management (ZZM)*, which received competences to govern all parks, forests and green spaces in the city. Before creating this unit, responsibility for the cities’ green spaces was divided among multiple faculties.

There are several spatial planning documents that might include UF-NBS; for example, the *Study of Conditions and Directions of Spatial Planning* and *Local Plan of Spatial Development* contains information, requirements and programmes of green spaces. The *Local Plan of Adaptation* includes studies on climate change impact on the city and ways to mitigate and adapt, and mentions greenery on multiple occasions. There is also the “*Powiat Programme to Increase Afforestation in the City of Kraków for the years 2018-2040*”, which aims to increase the forest area in the city by at least 8%. The most notable planning document and initiative in Kraków is the *“Directions for the development and management of green areas in Krakow for 2017-2030”*. It took the form of a wide cooperation among various city units (which usually

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have their own strict competencies and do not work together), experts and used social participations methods - workshops with citizens were organised in every district. The document covers various aspects of blue-green infrastructure in the city - spatial planning, land property, cultural heritage, social necessity of green spaces and their accessibility. It also highlights necessary actions in real estate management, spatial planning and cultural heritage management.

Citizen science participation & contestation. Participatory governance in Poland has many obstacles; it is difficult to say that administrators and decision makers are accustomed to converse with their citizens. Authorities are usually hierarchy-based with strictly divided competences, which does not help to engage citizens in projects. Social participation is often reduced to limited groups of active citizens, project meetings and consultations. There are some initiatives, however that can certainly help build cooperation between the city and its citizens. Those connected to NBS are initiated by the Kraków Municipal Greenspace Authority (ZZM) and often focus on activation and education. Another example of social participation in Kraków are consultations of “*Development and Management of Greenery in Kraków, 2017-2030*”, which included open workshops in every district (18 in total) and a consultation point allowing citizens to learn about, discuss and comment the document.

Kraków has also been the site of many informal movements and actions. They are usually initiated by a local NGO (there are many concerned about nature, public space and pollution) or a group of citizens who see their surroundings are lacking, or believe the formal paths are too long. These groups take various approaches; some of them focus on guerilla-like actions, others concentrate on community and policy-making. Some actions were in cooperation with the Kraków Municipal Greenspace Authority. An important tool in shaping urban greenery and social participation is the Kraków civic budget (since 2014), in which a high percentage of submitted and financed projects relate to green areas, and which is systematically growing (~5 million PLN in 2015 to ~10 million PLN in 2018).

Socio-economic trends. Kraków is one of the main centres of science, tourism and culture. During the past several years greater touristification and gentrification of the old town and uncontrolled urban sprawl took place. The latter results from high housing demand, but also from growing prices in the city centre. It is also a consequence of giant investment pressure on green spaces, which are systematically decreasing, air pollution due mostly to outdated heating in Kraków, but also wood-based heating in neighbouring municipalities, car traffic and geography (Kraków is located in the river valley). The COVID-19 pandemic slowed down, or even temporarily stopped touristification. Other challenges however will still influence the city in the following years. Furthermore, the population of Kraków, which is currently about 780 thousand, is growing. This might further increase investment pressure on green spaces. The current tendencies of citizens to participate in local governance and expectations of greener policies may influence this trend.

Major challenges:

1. Conflicts of interest, both human-human and nature-human. The strong conflicts among different stakeholders with opposing interests. The current and future investments in green areas (especially River Parks) and making them available to users creates the risk of their degradation (noise, light pollution, littering, destroying plants, etc.).

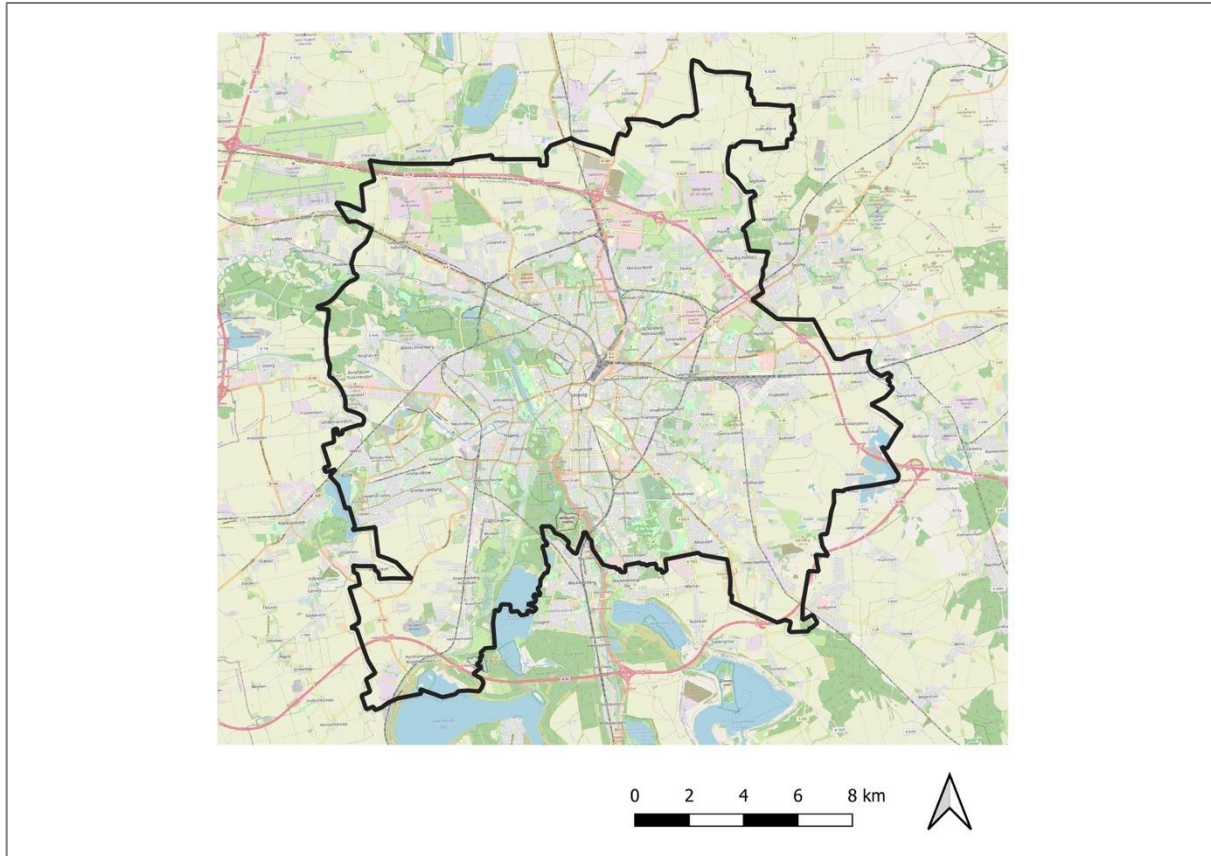
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2. Problems with local law enforcement, especially municipal spatial development plans resulting in highly intensive development and a lack of biologically active areas.
3. “Silosity” of city management; too many institutions responsible for urban green areas and the protection of urban ecosystems, their dispersed and unclear responsibilities, lack of coordination and a coherent strategy. Limited cooperation between the municipality and stakeholders, as well as among various social groups.
4. Degradation of the environment in Kraków, low quality of surface water, very low quality of air (smog), and heavily degraded brownfields.
5. Lack of tradition and models of involving business and private owners in the protection of urban green areas; high resistance to comprehensive regulations ensuring effective protection of trees and plants on private lands; problems with making certain green areas available (e.g., monasteries and churches, housing estates, schools and universities).

Knowledge gaps:

1. Methods of creating and maintaining the protected green areas (e.g. the River Parks) to balance their ability to be used by citizens and their effective protection, without losing biodiversity. The rules of making them available and using them.
2. How to build public awareness about the value of green areas and ecosystem services, how to influence reasonable needs and expectations of various groups of stakeholders.
3. The complex and efficient tools and regulations of spatial planning.
4. Methods of precise evaluation and determination of ecological continuity; taking into account and balancing all types of continuity (needs of various species of plants and animals, hydrological, city ventilation, alternative forms of transport, etc.).

Leipzig, Germany



Leipzig is the largest city (a municipality with city status due to its size) in Saxony, Germany, with an area of about 30,000 ha and currently almost 600,000 inhabitants, benefiting also from protected riparian forests, stretching from the south towards the north. The city was affected by massive population loss, increasing vacancy numbers and unused brownfields after 1990. Population losses slowed down by the turn of the millennium. Since 2012 Leipzig has repopulated by about 10,000 citizens (2%) per year. Consequently, pressures on the city's remaining open spaces are strongly increasing. Former industrial sites or residential buildings have now become opportunities for residential and commercial development but also support urban biodiversity and provide recreational services.

State of the Urban Forest. Leipzig is a fast-densifying city with associated impacts on green spaces and forest areas. For about 23% of the urban population (as of 2015) there is no public green space accessible (min. 2,000 m²) at a distance of 250 m (approx. 5-min walk). For 32% of the population such green spaces are accessible, but they are not sufficient for a minimum supply of 6 m² per inhabitant (the goal of the local authority). In individual urban districts, the supply of public green spaces is quite diverse. The location and size of the green spaces as well as the building structure and the population density play a major role. In the inner-city quarters with perimeter block development there is already a shortage of green space. The high density in neighbourhoods reinforces the competition for use and reduces the scope for green actions. Even allotment gardens and wooded areas close to residential areas cannot compensate for the

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deficit. They do not meet all the requirements, especially for sport and play in public green areas, fulfil other nature conservation and forestry functions (forest), or are only open for specific groups (allotment garden). Within the urban heat islands, brownfields, allotment gardens, sports fields, cemeteries, parks and green spaces and large green inner courtyards are indispensable cold air areas, which additionally have a special role for air hygiene due to their filter function.

By far the largest share of street trees is the result of the planting period from 1996 to 2005. The number of fallen trees is compensated by plantations; in most cases even significantly more street trees are planted than felled. Despite this effect, Leipzig's street tree stock only increases slightly. The target of the Clean Air Plan of planting 1,000 additional trees per year has not been reached since the mid-2000s. Apart from the small-scale pattern of inner-city open spaces, the most important climate-ecological compensation area and fresh air producer is the alluvial forest of Leipzig. The alluvial forest along with the associated water network of the Elster-Pleiße-Luppe floodplain is the most important area for biodiversity. Moreover, other floodplains with mainly near-natural areas are designated as protected areas. Supplementary areas with buffer functions for the core habitat areas can be found in the agricultural landscape, in recultivation areas of post-mining landscapes in the southern region, and in the area of renaturalised urban wasteland (Plagwitz railway station).

Governance, planning, and policy landscape. The territory of the Sonian City spans different administrative boundaries. Relevant authorities include the local governments of 11 municipalities: the provincial governments of the Flemish Brabant and the Walloon Brabant, and the regional governments of the Brussels Capital Region, Flanders and Wallonia. The federal government and the Language Communities have certain competences in this territory, but only play a rather indirect role. This administrative fragmentation implies that the planning approach is not uniform throughout the territory, but follows the borders of the three regions resulting in three separate planning frameworks.

As far as the core area is concerned, one of the most important policy instruments is the "Natura 2000" network, in which the 'core' part of the forest and some neighbouring green areas are registered. This is a European network of natural or semi-natural sites important for both its fauna and flora. Unlike many nature reserves, Natura 2000 areas are not "closed" reserves: human activities are still allowed as long as they do not compromise the "objectives for nature" in the area. Building on it, every region also has a management plan for the portion of forest under its jurisdiction. To foster cooperation among the different regions, the Structural plan for the Sonian Forest was drawn up and a platform of permanent cooperation was established in the form of the Sonian Forest Foundation. For the city/forest areas surrounding this forest core, the landscape of policies and regulations impacting UF-NBS is much more fragmented. Some provisions are included in more general policy and planning tools (i.e., not immediately targeting the environment) at the regional, provincial and communal levels. There are also some policy tools targeting environmental issues.

Citizen science participation & contestation. The "Baumstarke Stadt" programme offers sponsorships for urban trees that fall within the responsibility of the city authority. The sponsored tree is maintained by the City, but the sponsor can provide additional support, e.g. by watering the trees extensively during dry periods, keeping the tree disc free from weeds,

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loosening the soil surface of the tree disc (if not overgrown) to aerate the soil, checking the attachment of the tree-supporting post, cleaning the tree disc of debris, such as paper, or simply informing the department of urban greenery in case of larger waste deposits, damage to the tree or its holding device. Information about the “Baumstarke Stadt” programme is publicly available to interested citizens and is accompanied by special offers for various anniversaries, press releases and a leaflet. This all contributes to the identification of residents with their "green city".

Additionally, citizens have also been involved in the development of the street tree concept Leipzig 2030 in an extensive participation and coordination process. The street tree concept Leipzig 2030 was developed by a working group involving all relevant actors from the city administration and municipal companies. At the same time, citizens were able to actively contribute to planning in an extensive participation and coordination process. The concept is to be understood as a strategy for the maintenance and expansion of the street tree stock. Thus, different interests with regard to street trees were bundled, which finally resulted in a coordinated, comprehensible and implementation-oriented action instrument.

Socio-economic trends. The strong and fast demographic regrowth of the city of Leipzig after years of shrinkage is primarily driven by strong in-migration. In the 2000s, the city experienced a net influx, especially of young people. The in-migration surplus has increased over the last 15 years and reached the level of >10,000 net immigrants from 2011 onwards. This was also due to the increasing attractiveness of the city for job starters from the rural surroundings and increasingly from other larger cities and regions in Germany. Moreover, whereas the number of immigrants has remained at a consistently high level since 2011, the number of people arriving from abroad has increased significantly since then. The share of foreigners immigrating to the city has increased. International immigration is contributing to Leipzig’s rejuvenation because of the age structure of migrants.

During recent years, Leipzig’s labour market has stabilised and improved slightly. We have thus observed a constant decline of the unemployment rate from 14% in 2005 to 5.9% in 2019. Clearly related to this tendency, the rate of welfare recipients has also steadily decreased to a share of 17% of the total employable population. Even though the total number of older and long-term unemployed persons remains stable, their relative proportion is increasing. These numbers reveal that access to the labour market is not possible for everyone, even though the city is growing strongly. Today, Leipzig is one of the largest cities in Germany with the highest shares of people living in, or at risk of, poverty. In 2012, 30% of Leipzig’s population was at risk of poverty, 11% above the national level in Germany. Among Germany’s biggest cities, Leipzig has the largest share of low-income households (more than 62% with income below €25,000 per annum). Moreover, during the last few years an increasing number of refugees have been assigned to the city, which will have an impact on the city’s ethnic make-up and on processes of diversification, as well as on patterns of residential segregation. Access to Leipzig’s labour market is more difficult for migrants than for Germans. Although many jobs have been created, a substantial proportion was to a large extent characterised by low wages and precarious contracts, especially in the secondary sector. This characterises the city’s labour market until today.



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Major challenges & knowledge gaps. Due to a lack of financial and human resources, green space maintenance cannot achieve its full performance in terms of intensity of care. The scope for action of local authorities is limited, so that the maintenance cannot meet the demands of use. In addition, there are institutional barriers due to the non-transparent communication of responsibilities within the city administration. For instance, the tasks of maintenance are divided between the responsible office and a city cleaning company. This can lead to problems of unclarified responsibilities within the administration as an institutional barrier, due to the scattered division of responsibilities for green space management tasks, and further to complications of target-oriented coordination and control in the city administration. In consequence, the care and design of the urban green spaces by actors in the field of green space management cannot be sufficiently achieved. The main challenges are therefore the lack of a long-term financial basis and institutional structures that are difficult to change, which may make implementation more difficult. Also, the poor equipment or design, especially of public parks and meadows, can be regarded as institutional barriers in planning and design. Besides the lack of infrastructure such as poor road connections within the green area, this covers also legal reasons as institutional barriers. Private green spaces are therefore subject to the obligation to ensure safety on roads. The owner must therefore be liable if someone on the private property suffers damage. As a result, private green spaces are usually fenced and not available to the public. The situation is similar with brownfield sites, especially in the inner-city with high land potential to be revitalised and public open spaces to be developed. Unresolved ownership structures or inheritance disputes may affect the development of these and inhibit potential open spaces. Private ownership restricts the development of urban green spaces. Certain restrictions are also imposed on protected areas. Restrictions on access arise here due to the nature conservation law. In favour of nature, this results in various restrictions on use depending on the status of the protected area. Due to the strict provisions and unclear cooperation structures within responsibilities, protected areas can be regarded as institutional barriers. For instance, the respective protected areas can either prohibit or significantly restrict the development of road systems. The differing interests of the municipal administration on the one hand and the nature conservation authority on the other hand also constitute an institutional barrier to access protected areas. This requires a coordinated cooperation of all parties involving actors within the administration, as well as other actors at city level.

Llobregat Valley (Lower Llobregat Valley), Spain

The Llobregat river basin, with an area of 4,930 km² and a total length of 175 km, is the largest inland basin in Catalonia. The course of this river has been widely exploited for various uses: agricultural, industrial and consumption, among others, for many decades. The part of the Llobregat basin that belongs to the Metropolitan Area represents only 4.74% of the total and corresponds to an intensely humanised space. However, this area plays a key role in the ecological and social connectivity of the Metropolitan Area. It concerns a space with different demands and great potential in terms of the contribution of ecosystem services, which coincides with a fundamental corridor of infrastructures and in the main gate of Barcelona, since both the port and airport are located in their deltas. Despite this pressure, which has resulted in a dramatic reduction in the river area and its quality in recent decades, the river space still offers opportunities to promote ecological and social connectivity, as well as to maintain the ecosystem and improve metropolitan biodiversity as well as its role as an ecosystem service

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provider in the metropolitan area. Many recent restoration actions led by AMB have significantly improved the quality of this space. Consolidation of the riverside parks El Prat and Sant Boi de Llobregat was an important part of environmental recovery along the Lower Llobregat Valley. Special focus was put on the dynamic aspects of the river landscape, enhancing and combining biodiversity recovery, the multiple functions of green spaces and the needs of the community (recreation: creation of walkable path and bike trams).

State of the Urban Forest. Most of the area belonging to the Lower Llobregat Valley river corresponds to non-urbanisable soil and is part of various protected areas, especially to Parc Agrari del Baix Llobregat and a smaller part of the Llobregat Delta. As for the riparian forests, the Llobregat river in its metropolitan section follows a mostly rectilinear route, practically channeled for the most part and without a meandering trace or a consolidated “natural” riparian forest. There are only a few patches of *Populus*, *Salix*, *Fraxinus*, *Alnus*, *Ulmus* or *Tamarix* that are largely the result of recent plantations, but which in no case form the characteristic plant communities and the structure of these forests. Only small, well-preserved pieces of riparian forest have been identified in some areas (i.e., close to Molins del Rei or Sant Andreu de la Barca). Preserving and connecting these patches with other green typologies would increase landscape connectivity and favour biodiversity. The agricultural activity of the Agrarian Park metropolitan area has a strategic value in the metropolitan area, and not only because it provides local food production but also because it plays an important role in the water cycle, increases the complexity of the landscape, guarantees ecological functionality, increases biodiversity, orders open spaces, reduces the danger of flooding and the danger of fire and helps to take advantage of the territory’s own resources with the logic of a green and circular economy. It is also important to encourage the treatment of edges between the urban fabric and open spaces through the recovery of agriculture, restoring degraded contact strips, managing intensities of use or ordering peri-urban uses, among others. UF-NBS can be related to preserving or recovering territorial “cultural memory” or past landscapes. The shrub fringes with woody Mediterranean species which limit the crops of the Agrarian Park of Llobregat are reservoirs of biodiversity (i.e., fauna) and have an important role in the biological control of pests. Another possible UF-NBS related to agricultural landscape is the recovery of certain Mediterranean species for croplands.

Governance, planning, and policy landscape. This area has a complex institutional framework, with multiple levels of government. The total length of Llobregat river corresponding to the Metropolitan Area of Barcelona is 30 km, along 16 municipalities, from Martorell to Prat de Llobregat. The main administrations with territorial planning competences are the Generalitat (The Government of Catalonia), municipalities (The City Councils corresponding to the above-mentioned municipalities) and special urban organisations and the Metropolitan Area of Barcelona. The institutional framework is also completed by the two public consortia in this area belonging to the City Councils, the Metropolitan Area of Barcelona, Generalitat or Diputació de Barcelona (Barcelona Provincial Council). These are represented by the Consortium of Agrarian Park of Baix Llobregat and the Consortium of Natural Area of Llobregat Delta, corresponding to the network of protected areas. The future planning document at metropolitan level will be the metropolitan PDU (*Pla Director Urbanistic Metropolità*; Urban Master Plan; AMB, BR, 2019), which will replace the old PGM. It will also be applicable in the municipalities along the Llobregat river, as they are part of the Metropolitan Area. The PDU has been shaped in 2015 and is an ongoing document which has been recently approved

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(2021). Related to the Llobregat study area, the plan considers the importance of the ecological structure within the metropolitan territory. The ecological structure is seen as an important axis related to water and includes the main hydrographic axes, water canals and coastal line, but also the other areas related to hydrology: aquifers, wetlands, lagoons, coastal areas and beeches. These elements belong to the blue structure, but are intrinsically related to green infrastructure planning.

Citizen science participation & contestation. The metropolitan PDU has already involved 500 experts and a complex participatory process, with more than 10,500 participants in the metropolitan area. One of the main objectives of this participatory process was to disseminate and explain the PDU process to the participants, assure stakeholder engagement and define territorial challenges. It is the first planning process at this scale, involving a participatory process from the first stages. Among the citizen science activities focussed on creating indicators of urban diversity in the area, it is worth mentioning the Observatory related to the urban butterfly monitor scheme (uBMS). The Observatory is based on a collaborative network of volunteers to obtain data on butterfly populations and has been recently expanded to the Metropolitan Area (<http://mbms.creaf.cat/>). To date, the Observatory includes butterfly observations from various urban green areas close to the Llobregat river: Parc de la Muntanyeta (Sant Boi de Llobregat) and Parc de la Font Santa (Sant Joan Despí). Other previous and current activities include informative online and visualisation tools, citizen engagement activities connected to planning processes in the metropolitan parks (e.g., the AMB “Wildlife Visualisation Tool” or ornitho.cat). With specific focus on the study area, it is expected that future collective data on new planning and governance approaches and on possible UF-NBS in the Lower Llobregat Valley river be collected by the **Living Lab Llobregat&Co** and the participatory mapping be created by AMB and CREAM in CLEARING HOUSE. The core of Llobregat&Co is the participatory process across a detailed map of the study area containing opportunities and challenges related to UF-NBS and other NBS over the territory. In this way Llobregat&Co creates a useful tool to visualise NBS for planners, researchers, as well as for citizens.

Socio-economic trends. The study area belongs to the Metropolitan Area of Barcelona, which is responsible of 52% of GDP in Catalonia. The Metropolitan Area of Barcelona is a complex territory dealing with important socio-economic pressures. Population aging increased by 8%, and 54% of the population has problems accessing a home. Recent simulations which analyse COVID socio-economic impacts in the Metropolitan Area (Cruz et al., 2020) estimate that the average annual net income of Barcelona’s metropolitan households has shrunk between 7% and 8% in 2020 (between 32,330 and 32,036 EUR). Extreme poverty is also increasing (50,000 more people, resulting in a total of 221,000), and there is a slight increase in the intensity of poverty. According to the same study, the most affected social profiles by the current post-COVID economic crisis are children, the young population, the population of migrant origin and the working classes. The 12 municipalities belonging to the study area totalled 275.569 inhabitants in 2020. Cornellà de Llobregat is the most dense municipality in the study area (12,866 inhabitants/km², data corresponding to 2020). GDP/capita corresponding to Baix Llobregat county is 33,000 EUR. Population growth with migration background has a gross rate of 11.6 per 1,000 inhabitants in 2019, according to IDESCAT data (Statistical Institute of Catalonia). From the socio-residential point of view, the municipalities corresponding to the

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Lower Llobregat Valley are mainly included in the typology of zones with population aging and medium income families, and with few residential areas inhabited by upper classes.

Major challenges & knowledge gaps. One of the major barriers in this area is the lack of a well-defined governance model, which translates into an added difficulty in the planning, design and management of these spaces. In particular, a governance model shared by the main actors involved (multiple administrations, public operators and service companies) needs to be defined. Finally, the danger posed by river floods, the foreseeable scenarios of climate change that require specific planning and management, and the need to consider both high and low water regimes must also be taken into account. On the other hand, with regard to the river exclusively, an alteration of ecological processes was found, such as the recharging capacity of the aquifer or ecological connectivity. Other important barriers are: urbanisation of the landscape and the river environment, the low phreatic level, the quality of and availability to water vegetation, the management challenge posted by exotic species, landscape fragmentation and agricultural intensification, the lack of riparian forests (as potential river vegetation), and tree-related landscapes in general, and insufficient conservation measures for coastal pinewoods outside the protected areas. The following knowledge gaps are mainly related to research, planning and governance: insufficient knowledge of biodiversity (certain groups) and data on key ecosystem services in the area, but also the need for a common ground for prioritisation of biodiversity, ecosystem services and NBS at various administrative levels; and insufficient data on riparian forests and river pollutants. Other knowledge gaps in this complex area are how to enable institutional collaboration, connectivity and networks at various levels; how to assess knowledge and better share information on NBS and related initiatives; and how to include NBS in planning and policy frameworks at metropolitan level.

Compiled knowledge repository on UF-NBS based on academic literature review (Deliverable 1.2b)

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REFERENCE

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EXECUTIVE SUMMARY

The review of academic literature that is part of the CLEARING HOUSE knowledge repository is a key analytical tool for the creation of an evidence base on the impacts of UF-NBS on urban liveability, public health, biodiversity, and ecosystem services. The screening of academic literature based on a set of eligibility criteria resulted in an identification of 422 relevant records, that were analysed through a rapid review process. This analysis of records focused on selected key aspects including geographic context, nature-based solutions context, i.e., action conducted and/or type of corresponding green element studied, observed impacts, i.e., benefits/ecosystem services as well as ecosystem disservices, and research context including societal, economic or environmental challenges addressed, as well as methods and data used.

Reviewed records focused on a total of 67 countries, predominantly located in the Americas, Europe, Asia, and Australia. 59 unique types of green elements were identified, with urban and peri-urban (riparian) forests, parks, street trees, and residential green most often mentioned. The most frequently described actions include monitoring actions, greening, afforestation and reforestation, ecosystem management, species diversification, and restoration actions; however, a significant number of academic records does not study a specific intervention. Common challenges providing the context of case studies include nature conservation and restoration, the management of green spaces, support of sustainable development, decision-making and planning, the improvement of public and human health and well-being and of the quality of life, and mitigation and adaptation action. Benefits most often targeted or identified include the maintenance of biodiversity, the provisioning of recreational opportunities and restorative potentials, the increase of amenity values, the regulation of air quality and of temperature, thermal comfort and humidity. A pilot Sino-European comparison has been conducted in addition, to identify similarities and differences in the aforementioned analytical aspects more specifically between Europe and Eastern Asia/China. Furthermore, on the basis of these findings, a set of research questions has been identified for further consideration within the CLEARING HOUSE analytical framework.

To ensure a rapid dissemination of findings, and to allow researchers and stakeholders access to these findings under their own analytical lenses, an interactive online dashboard has been developed. This dashboard can be accessed at <http://review.clearinghouseproject.eu>.

KEYWORDS

Knowledge repository, academic review, dashboard, research gaps, Sino-European comparison

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

1 Introduction and objective

The compiled knowledge repository on UF-NBS based on academic literature review is a key analytical tool to help creating an evidence base for successful UF-NBS implementations and their impacts on urban liveability, public health, halting biodiversity loss and re-diversifying nature. The objective of the repository is threefold:

- First, to review existing English-speaking academic literature on nature-based solutions, ecosystem services, and urban forestry.
- Second, to structure, filter and systematize the reviewed records, to establish an interactive dashboard which allows a user to interactively query and filter review findings according to various criteria, and to visualize and summarize findings.
- Third, based on a broad assessment of relevant findings and a Sino-European comparison using the dashboard, to elicit key research questions for further research on UFBS have been distilled that help restore, reconnect and rehabilitate urban ecosystems and habitats for the strengthening of public health and wellbeing.

The knowledge repository was developed in close collaboration with T1.1., *inter alia* capitalising on the UF-NBS typology developed under this task. Furthermore, the knowledge repository will feed into the Sino-European co-design event (T3.1) and the CLEARING HOUSE analytical framework (T1.5).

The review of academic literature feeds into the CLEARING HOUSE knowledge repository. The review process is split between the European and the Chinese project partners. European partners (led by partner HUB) focused on the review of English-speaking records, whereas the Chinese project partners (led by University of Hongkong) focused on reviewing academic literature records available in Chinese.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

2 Review process

In principle, the review process consists of the following steps (Figure 1): (i) query of relevant literature in the SCOPUS database; (ii) the screening of records that were returned from the query; (iii) the processing and analysis of records from an internal data store collecting the output of a web-based paper survey; and (iv) the presentation of findings.

The process is designed to allow for a continuous updating of findings in an iterative manner; if so done, the CLEARING HOUSE knowledge repository can be updated over the course of the project or, alternatively, used and re-used by other projects and teams.

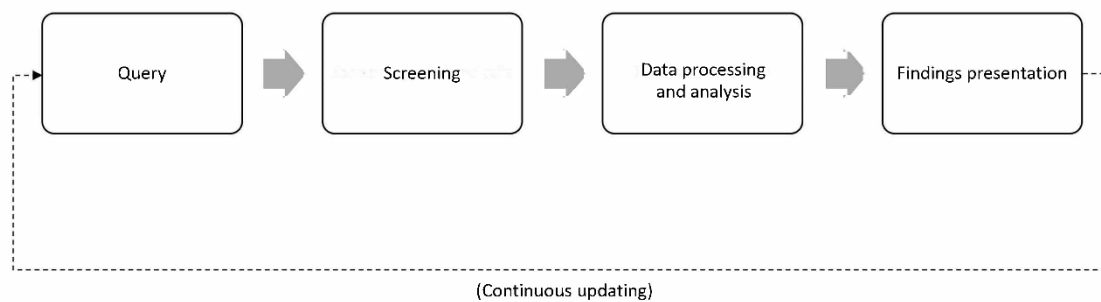


Fig 1: Overview of methodical and technical steps within the review process.

2.1 Query

The review of academic literature is based on the SCOPUS database as the largest multidisciplinary scientific database of peer-reviewed literature. We structured the literature review following the PRISMA guidelines (Moher et al., 2009; see also <http://prisma-statement.org/>). For the query we used the following code and key terms which reflect the objectives of the review to assess the effects or impacts of trees/urban forest as nature-based solutions on biodiversity, human health and well-being, and livability in cities.

```
TITLE-ABS-KEY(urban) AND TITLE-ABS-KEY(tree OR forest OR nature)AND TITLE-ABS-KEY('?'?'?'based-
solution'?'?'?)AND TITLE-ABS-KEY(biodiv* OR health OR well-being OR livability)

TITLE-ABS-KEY(urban) AND TITLE-ABS-KEY(tree OR forest)AND TITLE-ABS-KEY(planning OR '?'?'?'green-
infrastructure'?'?'?)AND TITLE-ABS-KEY(biodiv* OR health OR well-being OR livability)

TITLE-ABS-KEY(urban) AND TITLE-ABS-KEY(tree OR forest)AND TITLE-ABS-KEY(ecosystem W/5 service)AND TITLE-ABS-
KEY(biodiv* OR health OR well-being OR livability)
```

2.2 Screening

In the **screening process**, records were first screened for the year of publication based on a decision to primarily focus on more recent records, where recency was broadly conceptualized as having been published within the previous decade (i.e., 2010–2019 including). All records included as such were subsequently screened for availability, and if available, assessed for eligibility according to the following set of eligibility criteria:

- The record corresponds to (i) a *case study*; or (ii) the *description of a project*.
- The record considers (i) *one or more types or elements of the green infrastructure*; (ii) is about a (*tree-based*) *nature-based solution* (action or intervention); or (iii) is *broadly connected to trees* (e.g., through concepts such as tree cover, tree density etc.) as studied object.
- The record *specifically describes the geographic area of study of a given spatial scale* (e.g., the record may describe a case study at a specific locality at site or neighbourhood scale such as a given urban green space, or it may describe a study carried out at a set of localities such as cities within a region etc.). Review papers are typically not specifically locatable and have mostly been excluded from the record.
- The record describes—for the geographic area/scale and in the context of the object or action studied—*specific* (observed/estimated/modelled) *desired or undesired effects or impacts*, e.g., on biodiversity, public or individual health and human well-being, etc. As a consequence, for example, land-use change studies that do not consider such further effects of modelled changes were normally excluded.

These criteria are broadly formulated on purpose, to allow including as many diverse tree-related/induced effects on biodiversity, liveability, and public health and human well-being as possible.

Figure 2 summarizes the number of assessed records (including endpoints) through the eligibility screening process. The initial SCOPUS query returned a total of 1290 unique records. From this set of records, 291 publications were excluded since they were published earlier than 2010. Conversely, 999 records published in 2010 or later were included in the further screening process of which 229 records could not be accessed. 771 accessible records were retrieved and screened for eligibility according to the criteria listed above. From these records, 349 records were excluded resulting in 422 records which were included in the review and subsequently analysed.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

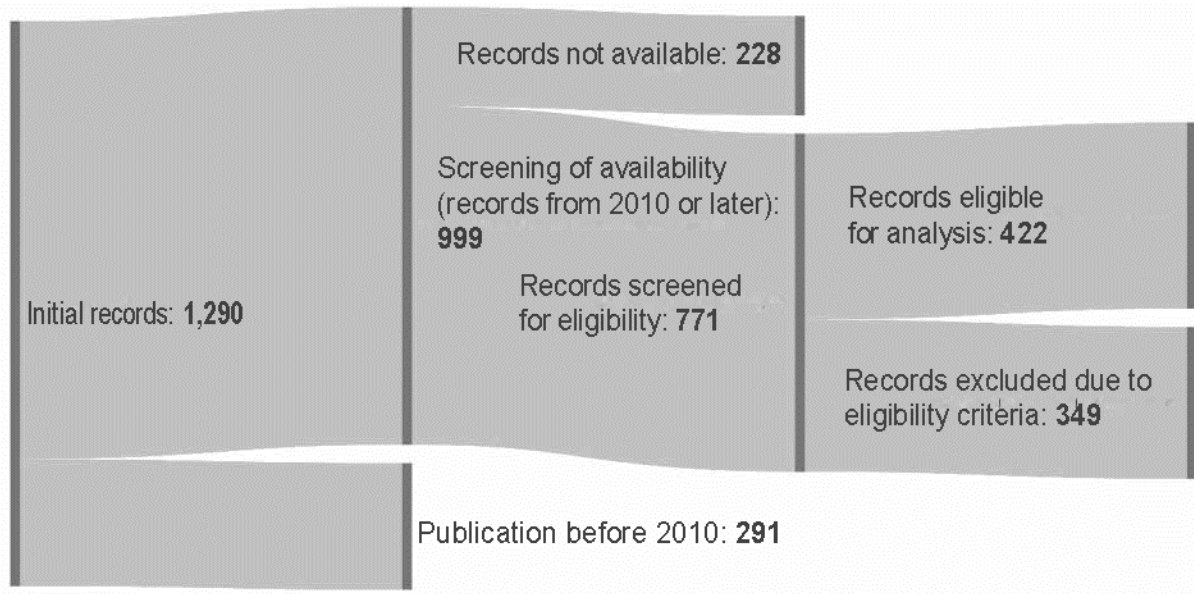


Fig 2: Sankey flowchart of the records assessed in the eligibility screening process. From 1290 initially retrieved records, 422 records were finally considered eligible for analysis.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

2.3 Data processing and analysis

The **analysis of eligible records** focuses on a set of pre-defined criteria, as coordinated in the CLEARING HOUSE consortium (Table 1). The analysis criteria were chosen to cover a broad range of aspects, with a focus set on the desired impacts/effects of tree-based nature-based solutions, and associated societal/environmental challenges. To facilitate the analysis of records, and more specifically, the sharing of findings, a submission form was setup online to allow reviewers to submit their results. The data submitted through this form is retrieved in spreadsheet format, and further processed.

Table 1: Analysis criteria for the CLEARING HOUSE review of academic literature.

Aspect	Sub-aspect	Description
Geographic context	Location	Name of country and localities (region, city, study site)
	Spatial Scale	Applicable spatial scale, e.g., site-level/neighbourhood level, city level, regional level etc.
Nature-based solution (action, type of corresponding green element)	Associated type of element of the green infrastructure (object of study)	Includes, e.g., different types of forests, street trees, green urban areas, cemeteries, allotment gardens, etc.
	Species-related information	Information on tree genus and tree species, and origin (native species), if available
	Action, intervention of study	Includes, e.g., greening or monitoring actions
Observed effects/ impacts	Desired impacts/benefits	The desired impacts and benefits/effects, targeted ecosystem services
	Undesired effects/trade-offs	Undesired effects and trade-offs observed, e.g., ecosystem disservices
Research context	Challenge	Contextual information, i.e., associated societal and/or environmental challenges
	Associated hazards and climate change	Hazard context, i.e., associated natural or anthropogenic
	Type of study	Type of study in respect to the methods used, e.g., quantitative, qualitative, or mixed methods
	Methods and data	A brief summary of methods and data used, and/or broader themes of methods applied

The **preparation and processing** of submitted data on findings from the analysis of have been implemented as a semi-automated workflow in the R statistical software with the following steps:

- Normalization of data: For example, many case studies did not focus on a single city, but a pair or group of cities. Such one-to-many (as well as many-to-many) cardinalities need to be resolved;
- Review and recategorization of submitted data as necessary, including the merging of rare categories into common themes, spell-checking etc.;
- Geocoding of relevant data, i.e., linking non-spatial information with geospatial data, including geocoding of localities/cities (through querying for location coordinates from a web service), and of countries.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

2.4 Findings presentation

The processed data have been feed into an interactive online dashboard to present the findings in an interactive and individualised manner (Figure 3). This dashboard allows a user to interactively query and filter review findings according to various criteria, and to visualize and summarize findings. To do so, a R Shiny dashboard has been implemented and remotely deployed for access via the World Wide Web. The dashboard can be accessed by the public at: <http://review.clearinghouseproject.eu>. The objectives of the dashboard, i.e., the desired functions, may be summarized as follows:

- Filter findings by selected criteria including world region, associated societal/environmental challenge, targeted benefits, actions studied, and mentioned species-specific information (e.g., tree genus);
- Visualization of (filtered) findings in an interactive manner, including user-modifiable charts, tabulation of data, listing of relevant records and access of these records through their doi identification;
- Export of (filtered) list of records (bibliographical information on the relevant records), with a summary, if requested. Moreover, review findings can be included as one-hot encoded data (Géron, 2019) for spreadsheet export;
- Generation of a report of (filtered) findings, with summaries and visualizations of findings.

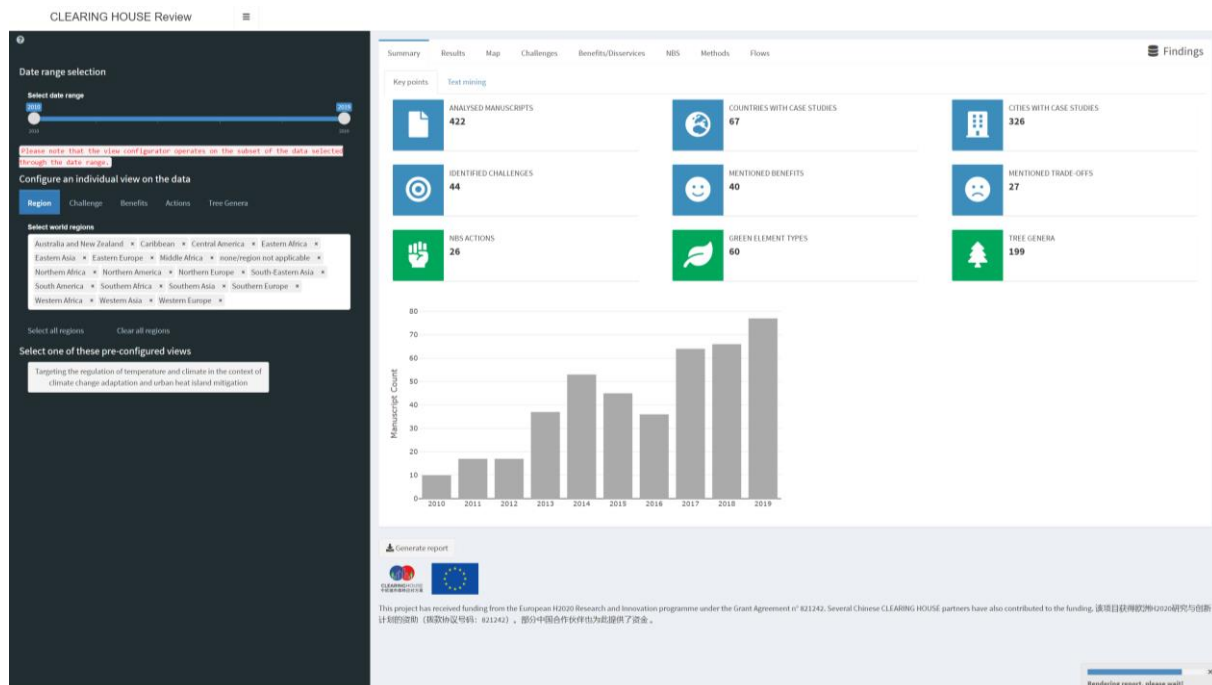


Fig 3: Interactive dashboard for the presentation of review findings.

3 Review findings – a global perspective on UF-NBS

3.1 Geographic context

The following maps visualize the number of mentions per country (i.e., the number of case studies or observations assessed from the analysed records) and the number of mentions per case study city overlaid (Figure 4). In total, case studies were found for 67 unique countries including USA, China and Australia covering the largest number of case studies. Similarly, the number of case studies for specific localities (cities) is shown in the map. In total, case studies were found for 326 unique localities (cities).

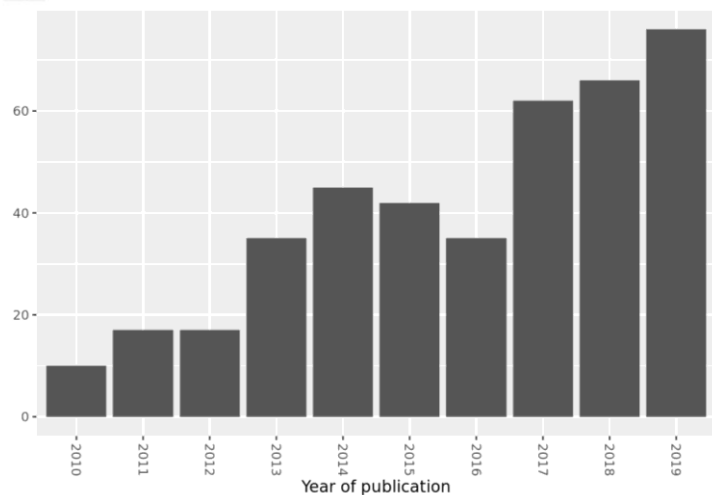
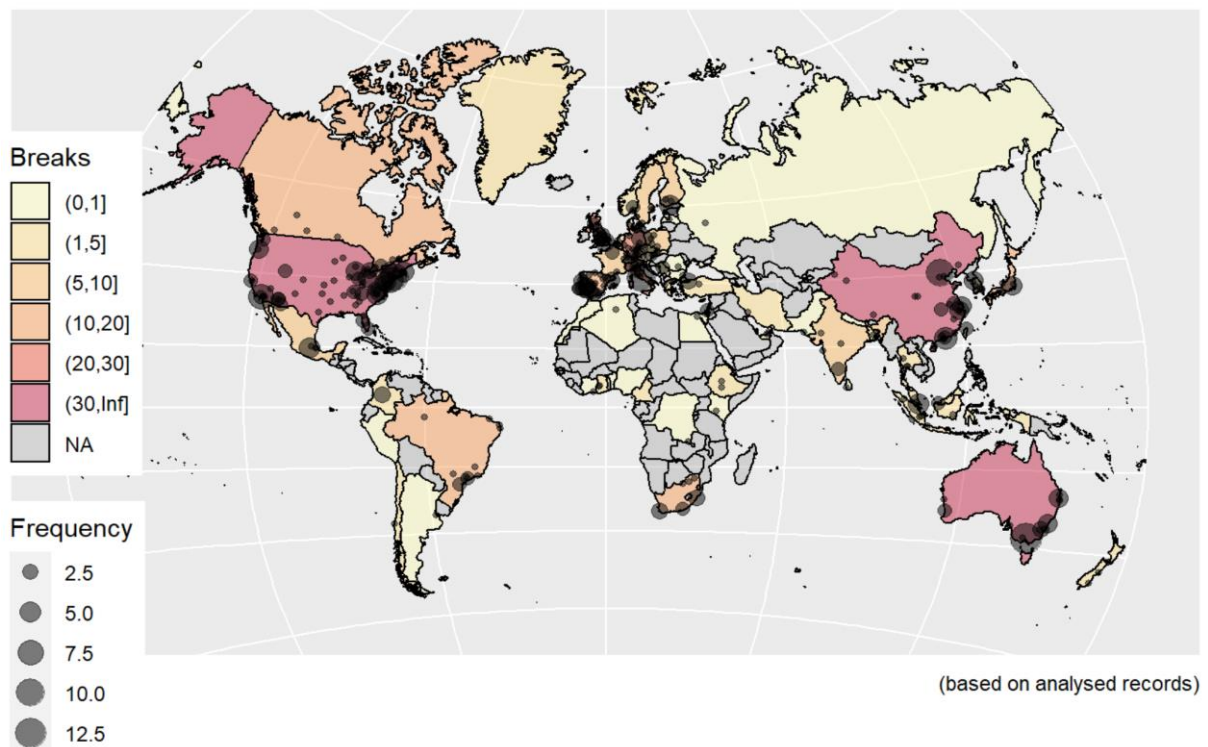


Fig 4: Number for case studies per country and number of mentions case studies for specific cities (map) and records over time as the number of records published each year (histogram).

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

3.2 Nature-based solution

The analysis of all records in all regions identified 59 unique **types of green spaces**, or respectively, types of elements of the green infrastructure, that were studied or observed. As Figure 5 highlights, *urban forests including remnant forests* are by far the most studied type of elements of the green infrastructure. This is followed by studies which either study trees as elements of *urban parks or public gardens*; *focus on trees on streets, boulevards, or promenades*; or extend their perspective to *peri-urban forests*. Furthermore, among the types of green spaces for which trees are studied there are also *riparian forest (incl. remnant forest in riparian areas)*; *residential/community green (excluding street, e.g., backyards, schools etc.)*; *green roof*; *allotment and community garden* frequently mentioned (see again Figure 5).

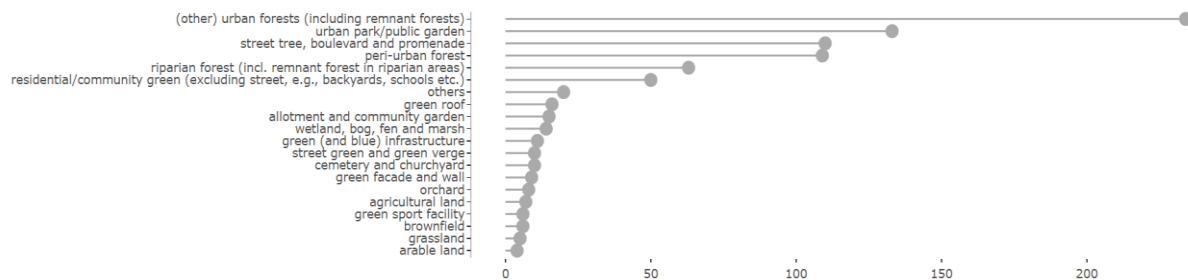


Fig 5: Most-frequently identified types of green spaces.

Species-specific information corresponds to data on the **genus or species of trees or woody species**. A majority of records (n=305, 72%) does not contain specific tree-related information. Only 117 (28%) records make mentions on specific families of trees, tree genera, or tree species (Figure 6 left). In order to retain data on as many tree genera or tree species as possible, in the few cases where no specific genus or species was given in the record, but only the tree family has been recorded, then this family is used instead of the genus. These records that make mention to species-related information allowed the identification of 199 unique tree taxa, with *Quercus* and *Acer* mentioned most frequently followed by *Tilia*, *Pinus*, *Platanus*, *Fraxinus*, *Eucalyptus*, and *Prunus* (Figure 6 right).

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

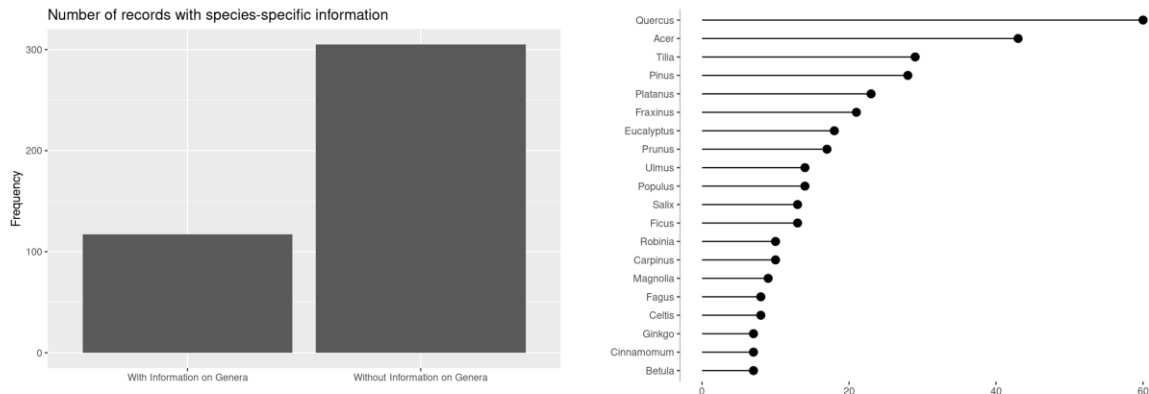


Fig 6: Number of records with or without more specific species-related information (left) and frequency of tree taxa (right).

The analysis of records identified 26 unique **nature-based solutions actions and interventions**. As Figure 7 shows, the three actions most often included is *forest and/or tree monitoring*, i.e., the regular and periodic measurement of certain parameters of forests and trees; *ecosystem management action*, i.e., the ensuring the long-term delivery of essential ecosystem goods and services by these distinct spatial entities (Smith & Harrison, 2016); as well as *greening*, i.e., the act of planting plants, the creation of urban green areas etc. Average frequencies refer to *species conservation and species diversification*, i.e., the maintenance of existing species or the introduction of novel species in planted areas, for example as a consequence of or for adaptation to climate change. This is followed by *afforestation and reforestation* action, i.e., the establishment of new or the intentional restocking of existing forests and woodlands, as well as *forest conservation*, i.e., the maintenance of forested areas (Pawar & Rothkar, 2015).

Less frequently listed are three actions referring to restoration. First, *ecosystem restoration*, i.e., the assisting in the recovery of ecosystems that have been (severely) degraded, as well as conserving of ecosystems that are still intact (Breed et al., 2020). Second, *forest landscape restoration*, i.e., the “ongoing process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes” focusing at the landscape level (Sabogal et al., 2015). Third, *spontaneous afforestation*, i.e., the abandonment of (former agricultural) land and the successive spontaneous afforestations. As shown in Figure 7, a substantial number of records (n=138) does not mention any specific action, as these case studies make observations of the status quo.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

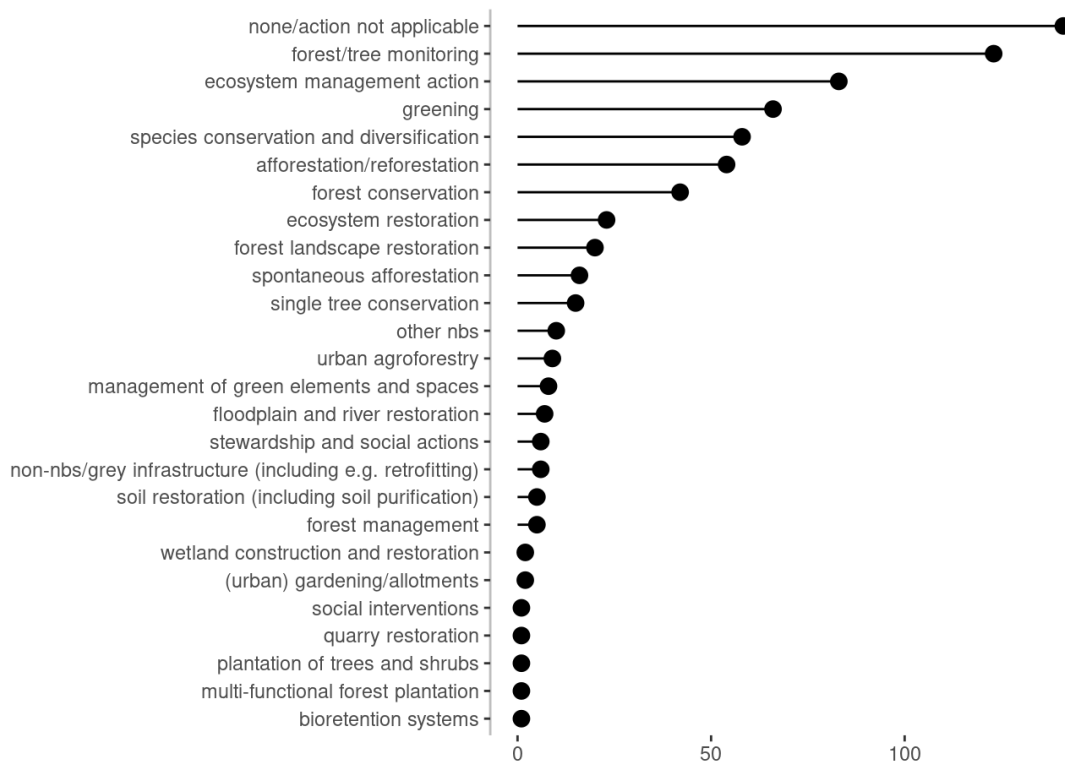


Fig 7: Identified nature-based solutions, i.e., actions and interventions.

3.3 Observed desired and undesired effects/impacts

Desired impacts can typically be mapped to specific ecosystem services provided by UF-NBS. The analysis of records identified 38 unique desired benefits. The benefits identified most often are the *maintenance of biodiversity, ecosystem health and habitat* as well as *recreation, physical activity, and restorative potential*; mirroring the objective to let trees and forest serve both an ecological/ecosystem health as well as human health benefits purpose. This dual objective is also mirrored by desired impacts mentioned with average frequencies such as the *regulation of air quality; the regulation of temperature, thermal comfort and humidity; amenity values, aesthetical pleasure and attractiveness*; as well as *climate regulation* (Figure 8). More specific desired impacts mentioned concern the *sense of place/cultural heritage; hydrological cycle and water flow regulation; shading and management of solar radiation*; and *economic benefits*.

Observed **undesired effects** (trade-offs) correspond to various ecosystem disservices. The analysis of records identified 25 unique undesired effects/ecosystem disservices studied or observed. Among them, the *displacement of endemic species, introduction of alien/undesired species; increasing temperatures and humidity and an associated decrease of thermal comfort*; as well as *(maintenance) cost* were mentioned comparatively often (Figure 8). These undesired effects are the counterparts of the most frequent mentioned desired effects in terms of maintenance of biodiversity, ecosystem

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health and recreation. This list of undesired effects for maintenance, ecosystem health and recreation can be extended by *allergenic potential, reduced health and well-being and biodiversity and habitat loss, fragmentation and degradation*. Mentioned with average frequencies are specific undesired effects referring to *soil degradation; to damages to built-up elements and infrastructures; increased water consumption; and unsafe conditions/fear* in green spaces.

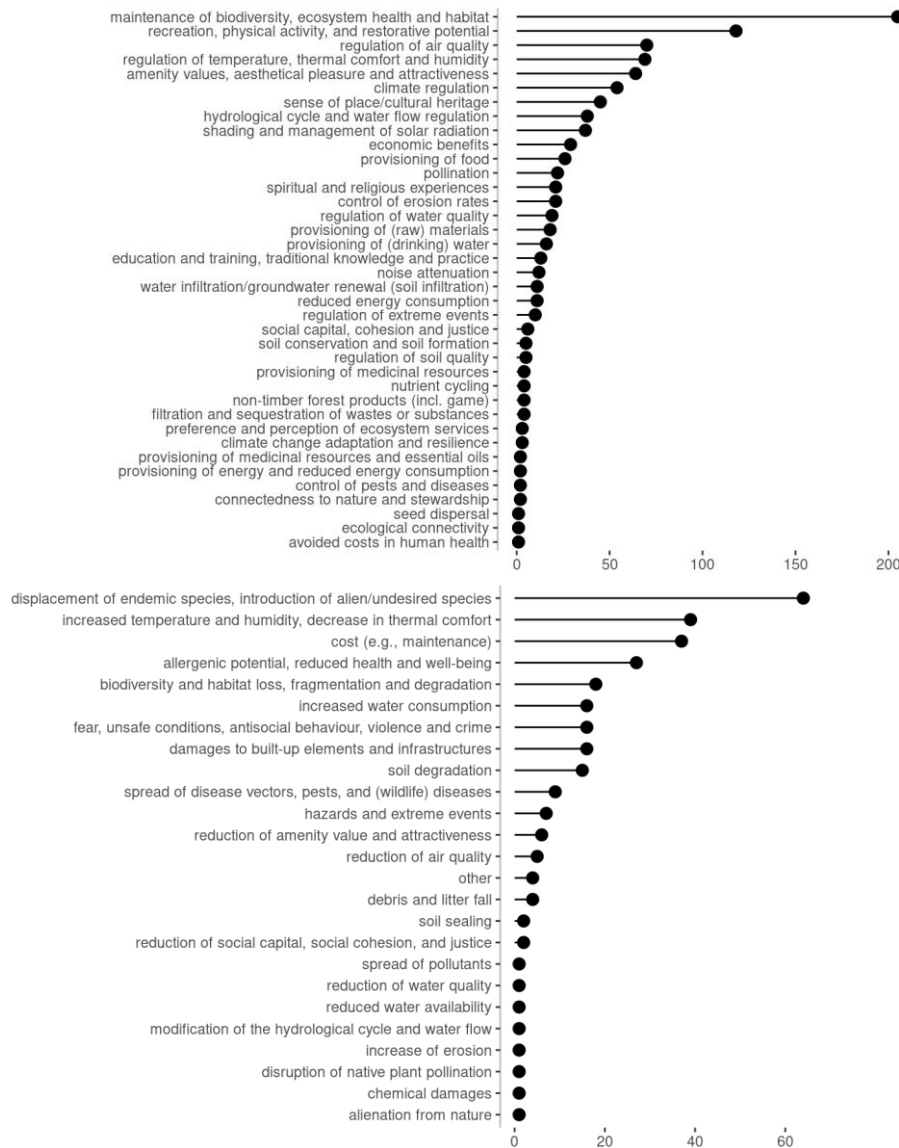


Fig 8: Identified desired impacts/benefits (upper chart) and undesired effects/trade-offs (lower chart) typically corresponding to specific ecosystem disservices.

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3.4 Research context

The analysis of records identified 26 **unique challenges**. As Figure 9 shows, *conservation action*; together with *support of (sustainable) development, decision-making, planning and design* are mentioned most frequently in the papers under study. If seen in combination, this allows to conclude on the need for supporting planning and decision-making process for conserving every aspects of nature and by this, as mirrored by Figure 9, contribute to *public/human health and wellbeing (physical and mental)*. Under this umbrella, other challenges are mentioned focusing on more fine-tuned aspects referring to *ecosystem health or restoration/rehabilitation; the management of green spaces, ecosystems, natural resources, and of protected areas*; accompanied by ensuring *quality of life (including attractiveness of place)* as well as the *mitigation and adaptation of hazards and climate change*. Less frequent mentioned are economic challenges of *funding and governance of nature-based solutions*; as well as *cost/cost-effectiveness*.

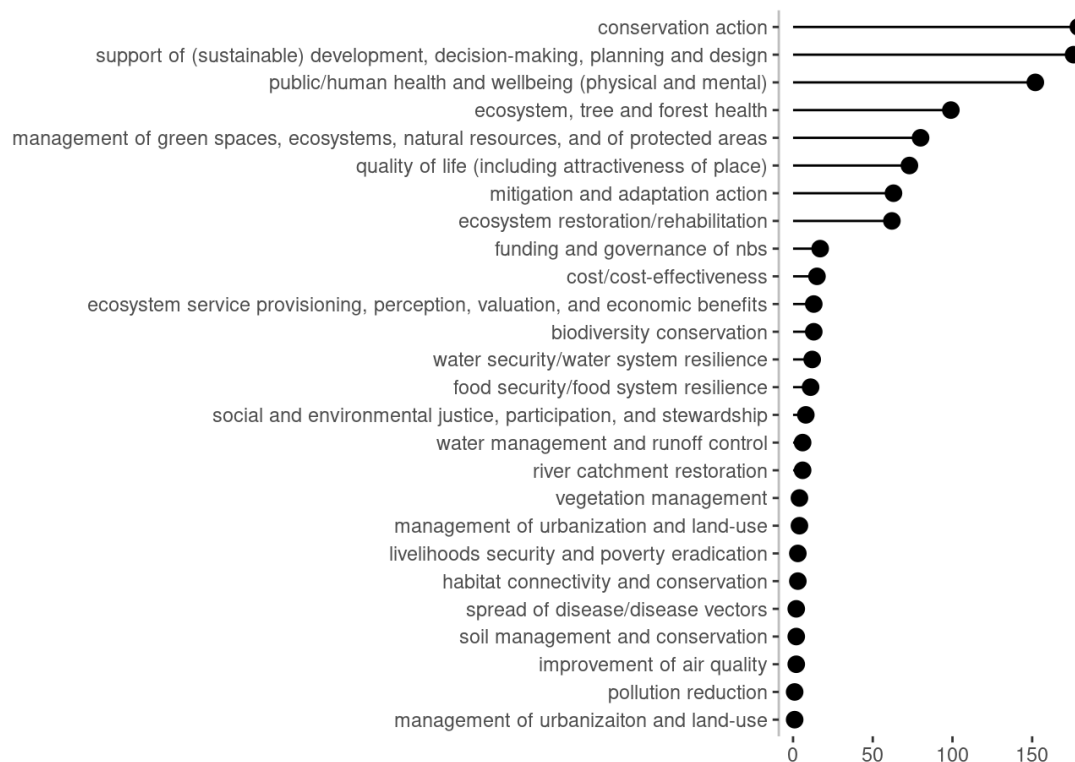


Fig 9: Frequency of identified challenges.

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Figure 10 provides a synoptic view on the findings by putting different aspects into a common context through a flow (Sankey) diagram. Each flow corresponds to the number of records that are relevant to a specific combination of categories, that are in turn described by nodes. In the Figure, the nodes shown on the left correspond to societal/environmental challenges (shown in red); nodes 2nd from left correspond to benefits (shown in orange); nodes 2nd from right correspond to actions (shown in cyan); and nodes on the right correspond to types of green elements (shown in dark green). Displayed are only comparatively frequent flows ($n > 20$).

Looking at Figure 10, it becomes apparent that *conservation action; ecosystem, tree and forest health; ecosystem restoration/rehabilitation; the management of green spaces, ecosystems, natural resources, and of protected areas; as well as the support of (sustainable) development, decision-making, planning and design* are the more prominent **challenges** driving actions that seek to provide the *maintenance of biodiversity, ecosystem health and habitat* as **benefit**. In the context of *supporting (sustainable) development, decision-making, planning and design*, but more so in the context of improving both *public/human health and well-being* as well as the *quality of life/attractiveness of place as societal challenges*, it is desired to achieve *recreation, support of physical activity, and restorative potential* as beneficial impacts, as well as to increase *amenity value; improve air quality and regulate temperature, thermal comfort and humidity*. The latter benefit is also in demand in the context of *mitigation and adaptation action* as socio-environmental challenge.

Actions that appear to be typically linked to the *maintenance of biodiversity, ecosystem health and habitat* include *afforestation/reforestation, forest conservation, species conservation and diversification, ecosystem management action, and forest/tree monitoring*. The latter action is also often studied in the context of the remaining benefits. However, to supply *recreation, support of physical activity and restorative potential; to improve air quality; and to regulate temperature, greening* appears to play a crucial role as **NBS action**. Note that looking at Figure 10, the substantial number of records that focus on a status-quo, i.e., not focusing on a specific action, becomes again apparent.

Types of **green elements** targeted by the **actions** mentioned above, or studied as status quo, often correspond to *urban forests/remnant forests and peri-urban forests (particularly in the context of afforestation/reforestation and forest conservation)*, but also include *urban parks/public gardens and street trees/boulevards and promenades (particularly in the context of greening as NBS action)*. *Ecosystem management action; species conservation and diversification* and especially *forest/tree monitoring* target all of these green elements.

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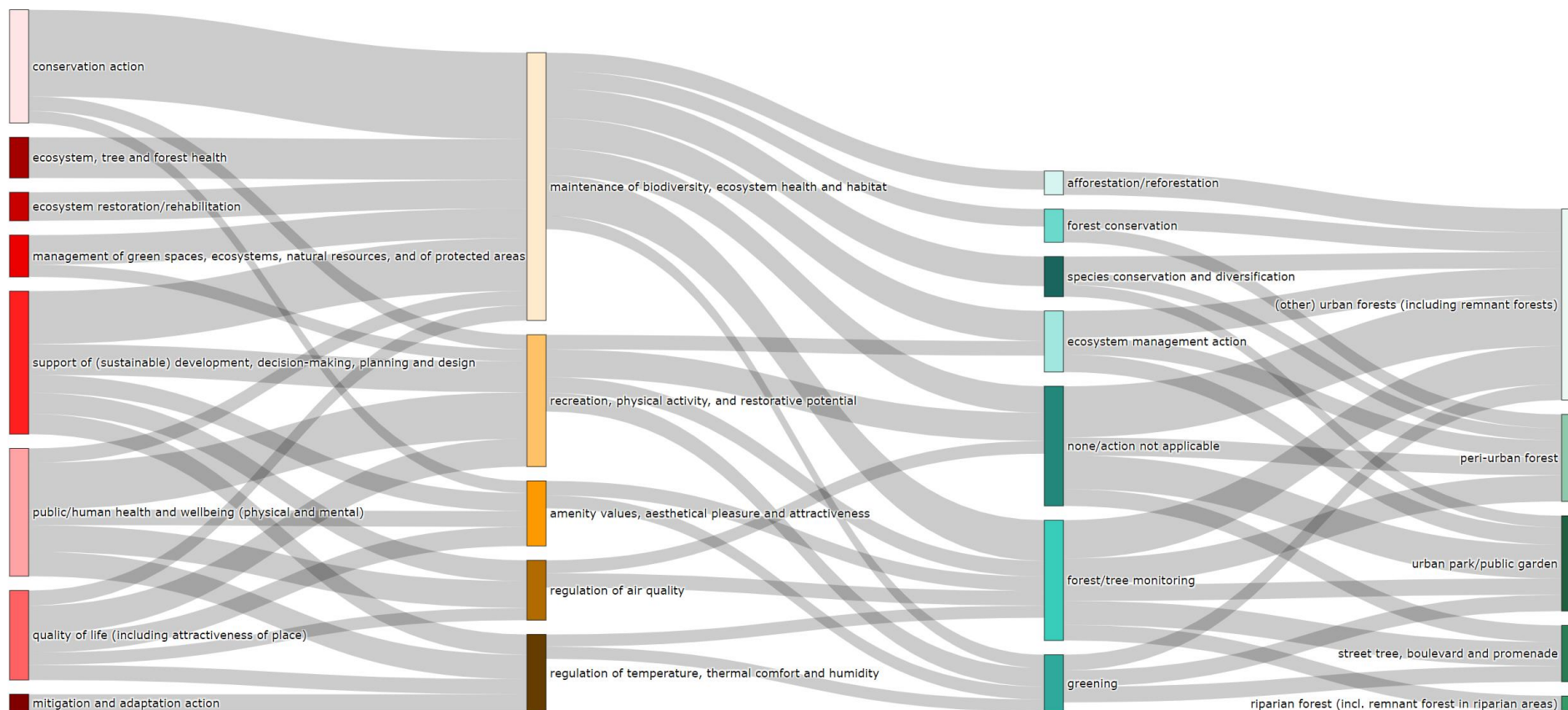


Fig 10: Synoptic view of the knowledge repository on UF-NBS based on academic literature review. The Figure shows comparatively frequent flows ($n > 10$) and challenges (left, red), benefits (2nd from left, orange), actions (2nd from right, cyan) and types of green elements (right, dark green) as nodes.

4 Sino-European comparison

In the following, we perform a pilot-kind of Sino-European comparison—being closely connected to the core dual concept of CLEARING HOUSE—for which the records of corresponding regions have been selected and analysed: for Europe, we selected Northern, Western, Southern, and Eastern Europe; while Eastern Asia basically consists of records with cases from China.

Among the most-frequently identified the **green elements** of *urban forest* and *urban gardens* have been predominantly analysed in both larger regions. In addition, among the studied green elements ranging next, no clear difference between both regions is obvious: *street trees*, *residential green*, *peri-urban* and *riparian forest* play an equal importance in both regions (Figure 11). Only among the less frequently studied green elements differences occur. While in Europe *allotment and community gardens* as well as *trees associated to buildings (green roofs, green facades)* play out much stronger, there are other green infrastructural elements which receive more attention in Eastern Asia in relative terms such as *pocket park*, *plantation*, and *institutional/commercial green*. Even only visible in the less frequently referenced classes of green infrastructure, these differences might be a good indicator of planning and governance schemes and priorities in both large regions which are an excellent starting point for further/future studies and also the practice part of CLEARING HOUSE (see chapter 5).

For the **identified actions** studied, differences between both large regions are much more fine-tuned. While in both regions, *forest/tree monitoring* is among the most frequent study action, there are, in addition, *ES management* as well as *greening actions* being of high importance for Europe while these actions range in the middle for actions in Eastern Asia (Figure 12). Interestingly, a second major block of actions is similar in both regions with *species conservation and diversification*; *afforestation*, *forest conservation* and *forest landscape restoration* being the most frequent taken actions – again, for Europe *ecosystem restoration* is completing this block. Clearer differences are visible again among the less frequent mentioned actions with actions for *stewardship*; *management*; *social interventions*, or *multi-functionality* being relevant for Europe but are not among the actions for Eastern Asia. And again, this hints to differences in land planning and governance schemes used and applied in both regions.

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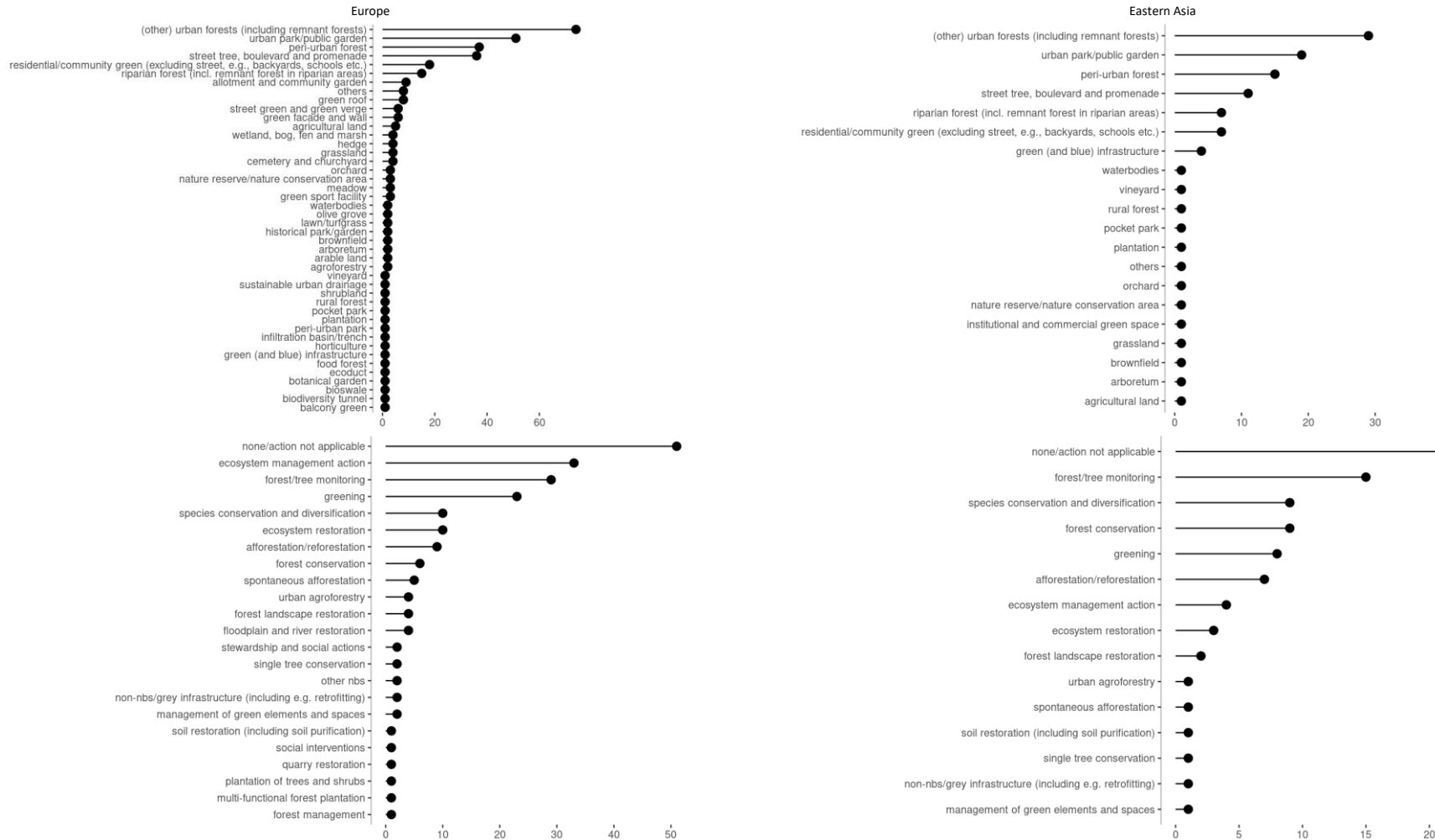


Fig 11: Most-frequently identified green element (upper charts) and identified actions (lower charts) comparing Europe and Eastern Asia.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

For the desired and undesired effects of the studied interventions, both regions largely mirror each other, however, with certain differences. In both regions, *maintenance of biodiversity; recreation and the regulation of air quality* are—unsurprisingly due to the heavy traffic burden everywhere—the most frequent **desired effects** (Figure 12). Similar, among a second block differences are hardly obvious with *amenity values; regulation of temperature; sense of place; climate regulation*; only the effect of amenities ranks a bit higher for Europe than for Eastern Asia. Climate change mitigation and adaptation UF-NBS seems to be one of the most important fields of application and knowledge exchange between both large regions although planning and management schemes (might) differ as the previous sections told us.

Another difference between the desired effect in both regions are the fact that the *provisioning of food; pollination and noise attenuation* are only showing up among the European desired effects while *soil conservation* is of higher importance for Eastern Asia. As *biodiversity; pest control in intact ecosystems* seems to be key what nature can deliver to stabilise urban systems and making them resilient to change, strengthening the pollination-related topic(s) in CLEARING HOUSE in and for both regions could be a worthwhile effort.

Clearer differences appear when comparing the **undesired effects** between the two regions (Figure 12). In Europe *costs (e.g. for maintenance)* is the most frequent undesired effect which, in contrast, doesn't play out that prominently in Eastern Asia. While in both regions the *displacement of endemic species; a decreased thermal comfort; fear/unsafe conditions and allergenic potential* are among the most frequent undesired effects, it is *water consumption and built-up damages* which additionally play a role for Europe. Again here, *allergenic potential* as an ecosystem disservice linked to major changes in nature in and around cities, could be an important indicator pointing to change and thus being an early indicator for intervention.

Compiled knowledge repository on UF-NBS based on academic literature review (D1.2b)

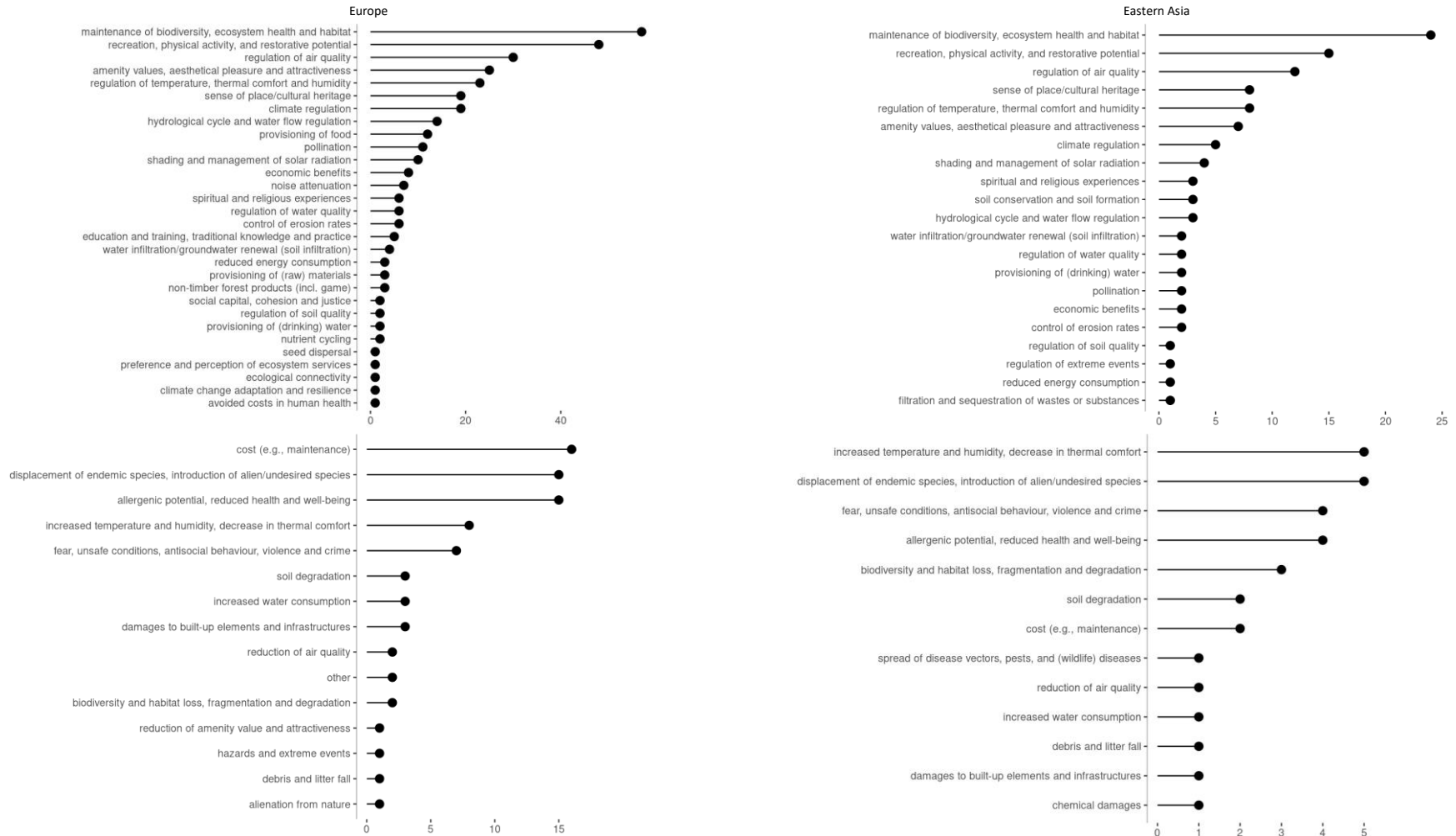


Fig 12: Most-frequently identified desired (upper charts) and undesired (lower charts) effects comparing Europe and Eastern Asia.

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Most of the identified **societal/environmental challenges** are the same and of the same relative importance in Europe and Eastern Asia with *support of (sustainable) development, decision-making, planning and design; nature conservation; public/human health and wellbeing* ranking top (Figure 13). An obvious difference is that in Europe the challenge of *climate change adaptation* ranks higher than in Eastern Asia which is a bit surprising and needs further study.

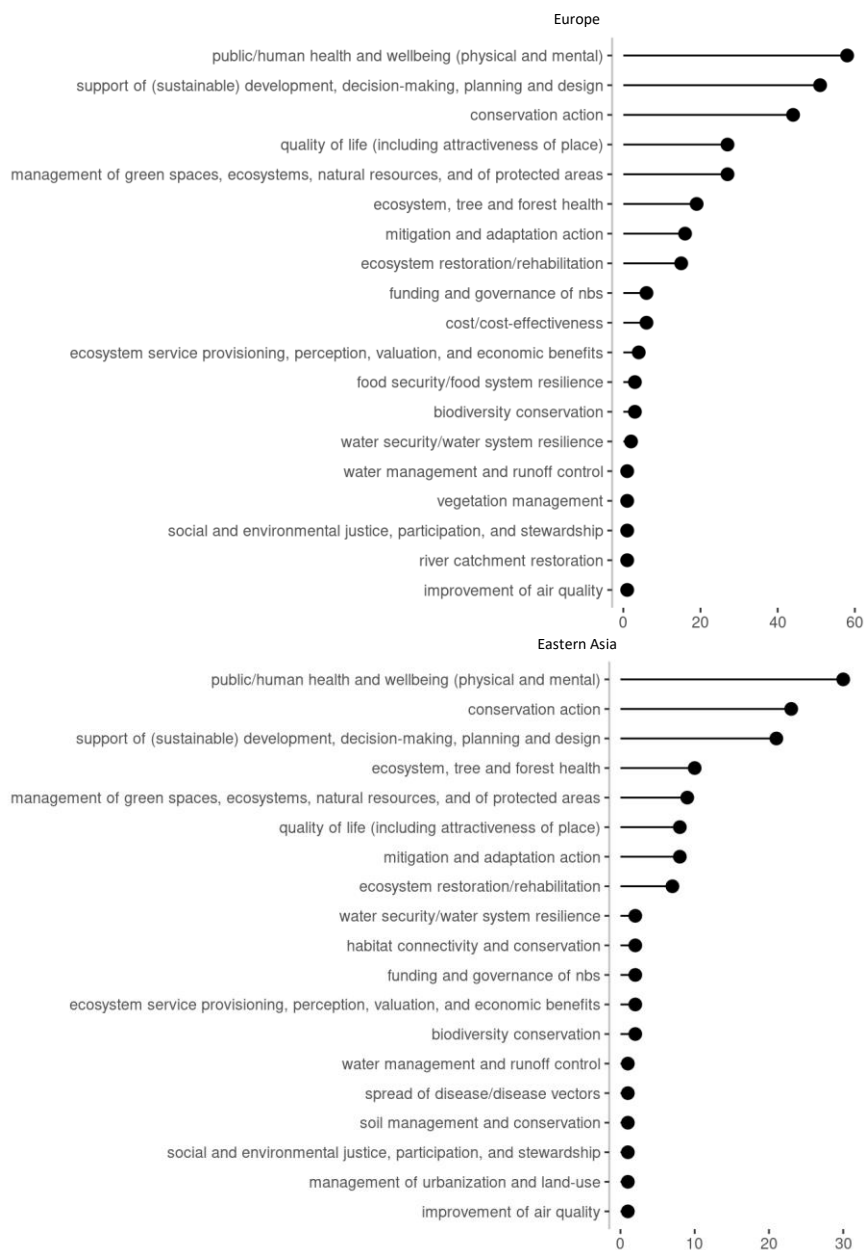


Fig 13: Most-frequently identified societal/environmental challenges comparing Europe and Eastern Asia.

5 Conclusion and future key questions

Having a compiled knowledge repository on UF-NBS as displayed in Figure 10 based on an international academic literature review following the PRISMA guidelines – and the introduced dashboard as its core-tool – could serve as the basis for several avenues of re-use and future research (Figure 14 and Table 2).

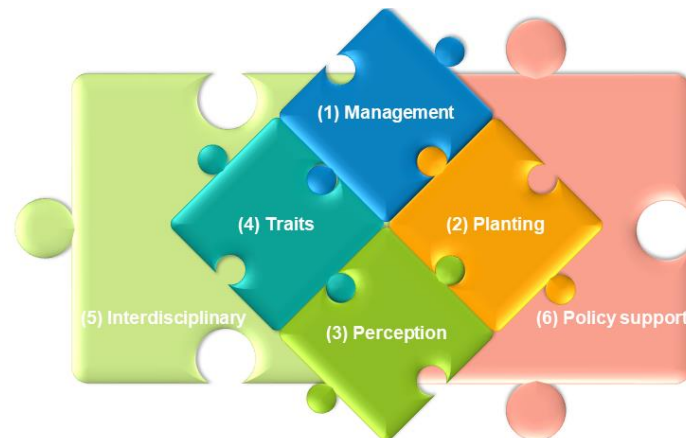


Fig 14: Jigsaw piece of further research fields and implementation questions (see also Table 2).

The research questions listed in Table 2 seems of a different role and particular importance in Europe and in Eastern Asia, more precisely, there are similarities and differences. In terms of the overall insights from the review, the fields of **human public mental and physical health** as well as **quality of life** is of great importance in both world regions. Both challenges seem to be key in terms of development goals (in line with SDG11) and thus also application ground for UF-NBS. Here, experiences exchange and best practice approaches will definitely serve for a successful further/future implementation of tree-based NBS. Ranking the most frequently used/applied green space types and UF-NBS reveals similarities between Europe and China, too: **Trees** as a part of the urban forest, as well as **forest-type landscapes within and around cities** are studied most with the goal to maintain or improve their biophysical functioning to secure human health.

Further, the review has shown that *forest and/or tree monitoring* are well established **nature-based solutions actions and interventions**. What is missing, however, is a stronger use of these tools for *ecosystem management and greening action* as well as the impact of residents' *perceptions and expectations* towards the look of urban green space on management decision and ES delivery (Research question 3 in table 2). Furthermore, to support decision-making, monitoring is also needed in terms of assessing and evaluating *management and stewardship* strategies including success & failure indicators and arguments (Research question 6), as well as a socio-political framing of UF-NBS including aspects of environmental justice (Research question 5). In Europe, these research avenues are slowly emerging since the last years. What is, in contrast, needed in both regions is an increasingly

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differentiated perspective on the **genus or species of trees or woody species**. This is crucial for managing for biotic and abiotic stresses such as pests, fire, and pollution to improve tree health (Research question 1), the general vulnerability, such as by drought, of trees and associated UF-NBS (Research question 4), as well as the species selection for new plantings in order to increase diversity for service delivery and forest resilience (Research question 2). Moreover, to support policy in upscaling NBS, a stronger evidence base is needed in regard to the cost effectiveness and cost benefit of UF-NBS, also in comparison to non-tree based NBS interventions as well as grey, non-NBS alternatives (Research question 6). Such assessments appear to be under-reported in the academic literature.

In terms of **desired impacts** the research on multifunctionality can be strengthened in both regions. While in Europe there is an established debate on the linkages between urban forests and human health benefits such as *noise attenuation* and/or the potential for the *provisioning of food* (Research question 5), in Eastern Asia positive and negative synergies delivered by UF-NBS are strongly related to *soil degradation* (Research question 4). One aspect which is most critical in Europe are (*management*) *costs* which is calling for a stronger policy support in order to minimise and safe costs e.g. for planting strategies (Research question 2). Moreover, innovations are needed in terms of public–private partnerships in the payment for ecosystem services implementation and management (Research question 1).

In addition, and in order to mitigate **undesired impacts** - esp. in terms of *biodiversity and habitat loss* in Eastern Asia and *damages to built-up elements and infrastructures* in Europe – requires stronger links to other disciplines for future research initiatives such as linking urban forests to social and economic research (e.g. in terms of income generation, social network stimulation etc., Research question 5) but also to urban and infrastructure planning (RQ1).

However, there are also obvious differences that could be identified between Europe and China (East Asia) using the academic review: actions such as **stewardship; management; social interventions**, or multi-dimensions and inclusive concepts such as **multi-functionality** being relevant for Europe are not among the actions having a particular importance for Eastern Asia. A further exploration of the role of urban governance and participative activism around UF-NBS in cities could be a promising task for CLEARING HOUSE explicitly including and discussing the experiences made in Europe and China to develop the overall co-design and co-management of UF-NBS further and in its full potential. We suggest making use of the idea of a **contrasting comparison** of the CLEARING HOUSE case studies here using both complex systems and assemblages theories which the results of the academic review clearly support.

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Table 2: Questions for future research on UF-NBS based on the compiled knowledge repository.

	<p>(1) What are management strategies for strengthening the adaptive potential of trees regarding climate change impacts while maintaining its multifunctional provision of benefits?</p> <ul style="list-style-type: none"> • availability of sunlight in street corridors and improvement of urban structure conditions, • conservation of native species and prevention of tree mortality, allowing natural succession, • public-private partnerships in the payment for ecosystem services implementation and management, • improve the ease of forest construction, participation in the planning process, and foster acceptance of UF-NBS, • managing for biotic and abiotic stresses such as pests, fire, and pollution in order to improve tree health.
	<p>(2) What are successful planting strategies in terms of</p> <ul style="list-style-type: none"> • urban planting conditions (e.g., soil media composition and chemistry), • planting location (particularly in regard to conditions within specific green elements, e.g., in bioswales/), • species selection: (typically only few) species due to preferences and perceptions of people vs. (many) species to increase diversity for service delivery and forest resilience
	<p>(3) What is the impact of perception on the provision and design of UF-NBS?</p> <ul style="list-style-type: none"> • perceptions of specific species (appearance, aesthetics), • perceptions of the design of parks and green areas (serene, nature, rich in species), • perception of socio-economic / socio-cultural conditions (e.g., park users, refuge space), • (multi)-sensory perception, • dependency of perceptions: the impact of residents' perceptions and expectations towards the look of urban green space on management decision and ES delivery.
	<p>(4) Detect biophysical and functional traits of trees and forests in urban settings in terms of</p> <ul style="list-style-type: none"> • allergenic potential and systematic insight in positive and negative synergies delivered by UF-NBS, • the role of the microbiome in the tree, • functional and/or species diversity of trees and tree groups in different urban settings, • decentral nature of UF-NBS, • connectivity / fragmentation / vulnerability (e.g., by drought) of trees and associated UF-NBS.
	<p>(5) Explore innovative UF-NBS aspects at the crossroad between different disciplines e.g. by</p> <ul style="list-style-type: none"> • linking urban forests and human health benefits and/or the potential for food production (trees result in the highest mental health benefits), • linking urban forests to social and economic research, e.g., in terms of income generation, social network stimulation, aesthetics, • socio-political framing of NBS (including aspects of environmental justice, environmental racism, urban political ecology).
	<p>(6) How can science support the governance, management, and stewardship of UF-NBS in cities?</p> <ul style="list-style-type: none"> • sound evaluation of the diverging models including assessment of what runs well and what not as well as the scale of governance, • success & failure indicators and arguments WHY UF-NBS work here and fail there (including learning from failures) <p>The relatively low profile of economic assessments and cost effectiveness requires further research</p> <ul style="list-style-type: none"> • appears under-represented in the academic literature, • upscaling of UF-NBS and substantive increases in city budgets to secure funding of NBS interventions will likely require a stronger evidence base, • evidence on cost benefit additionally needed in respect of grey alternatives, but also when compared to non-tree based NBS interventions.

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